A Life-Cycle Cost Data Base

For Assessing Acid Deposition Damage to Common Building Materials

Stephen F. Weber
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October 1985

NBSIR 85-3253

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Center for Applied Mathematics
Applied Economics Group
Gaithersburg, MD 20899

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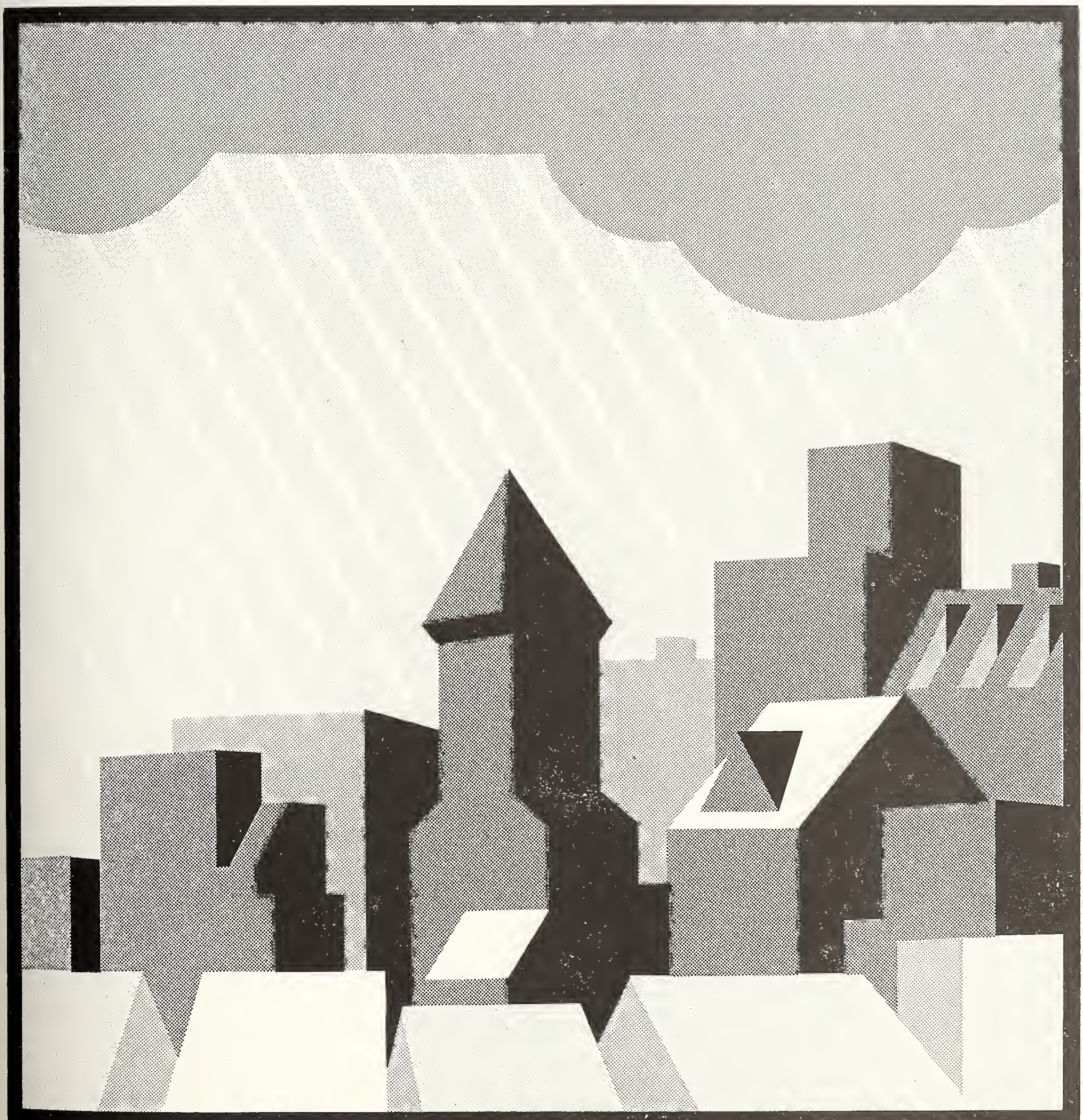
U.S. ENVIRONMENTAL PROTECTION AGENCY
National Acid Precipitation Assessment Program
Materials Effects Task Group
(Group G)



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Sponsored by:
U.S. Environmental Protection Agency
Washington, DC 20460

As Part of:
National Acid Precipitation Assessment Program
Materials Effects Task Group [Group G]

U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, *Secretary*
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

ABSTRACT

This report presents and documents cost data for the most economically significant building materials suspected of being damaged by acid deposition. The data are presented in the form of cost estimates for relevant maintenance, repair, and replacement (MR&R) activities, and are organized both by building component and by building material. The building components covered in this report include walls, roofs, fences, rain gutters, and downspouts. The materials covered include paint, limestone, marble, galvanized steel, copper, and masonry mortar. The documentation describes the data sources and presents detailed technical specifications for each of the 360 cost estimates contained in the data base. Summary statistics are presented for groups of MR&R activities, and the techniques of analysis of variance and regression analysis are used to address the problem of variation in the cost estimates within the same activity group. The report also explains and illustrates how the cost data can be used to estimate the economic cost of acid deposition damage to common building components and materials.

ACKNOWLEDGMENTS

The authors are grateful to Richard Livingston, John Spence, and Tom Lareau of the U.S. Environmental Protection Agency, to Susan Sherwood of the U.S. Department of the Interior, to Frederick Lipfert of the Brookhaven National Laboratory, and to Keith Eberhardt, Harold Marshall, Jonathan Martin, Mary Natrella, Stephen Petersen, and Joan Rosenblatt of the National Bureau of Standards for the many useful comments and suggestions they provided on earlier drafts of this report. Appreciation is also owed to Alice Booher, Amy House, and Laurene Linsenmayer of the National Bureau of Standards for their assistance in manuscript preparation.

SI CONVERSION

In view of the currently accepted practice of the building industry in the United States, some common U.S. units of measurement have been used in this report. In recognition of the position of the United States as a signatory to the General Conference of Weights and Measures, which gave official status to the metric SI system of units in 1960, appropriate conversion factors have been provided in the table below. The reader interested in making further use of the coherent system of SI units is referred to:

> U.S. Department of Commerce, National Bureau of Standards. The International System of Units (SI), NBS Special Publication 330, 1977 Edition. (Washington, DC: U.S. Government Printing Office, 1977.)

Metric Conversion Factors

Length:	1 inch (in) = 25.4 millimeters (mm)
	1 foot (ft) = 0.3048 meter (m)
Area:	1 ft^2 = 0.092903 m^2
Mass:	1 ounce (oz) = 28.3495 gram (g)

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1. INTRODUCTION

1.1 Purpose

One of the major objectives of the National Acid Precipitation Assessment Program (NAPAP) is to quantify the dollar cost of acid deposition damage to common building materials. This report provides a key element in the link between the physical damage functions being derived by the Materials Effects Task Group and the dollar estimates of damage to building materials to be derived by the Assessment and Policy Task Group. The purposes of this report are: (1) to present detailed data on the maintenance, repair, and replacement costs for common building components and materials that are susceptible to acid deposition damage; and (2) to describe how these cost data should be combined with estimates of the effects of acid deposition on component/material durability to derive a dollar damage estimate per unit of building component for each material. The cost data presented here have been obtained from several national data bases maintained and regularly updated by private firms. This project did not include the derivation of new data. The objective was rather to identify the existing data sources and to evaluate their usefulness for estimating the costs of acid damage to building materials.

1.2 Scope

The particular building components and materials included in this report were selected on the basis of the original Building Inventory Worksheet for Pilot Study that was developed as part of this research project and used in the Materials Inventory Survey Pilot Study conducted in New Haven, Connecticut. (The Worksheet is included in appendix A of this report.) The components and materials given in the revised Building Inventory Worksheet used for those sites surveyed after the New Haven Pilot Study are substantially the same as those in the original Worksheet. The revisions consist mainly of reorganization, simplification, and the addition of an explicit system for computer coding of the inventory data.

The list of building components and materials for which cost data are included in the data base is presented in table 1.1. Five basic components of buildings are included: walls, roofs, rain gutters, downspouts, and fences. For each of these components, several building materials are specified. These particular component/material combinations were selected because they are expected to contribute significantly to the magnitude of the economic damage resulting from acid precipitation. This is expected for several reasons. First, these components are commonly found on the exterior of buildings, and are therefore exposed to acid precipitation. Second, the materials specified here are susceptible to damage from acid precipitation, according to damage functions being derived in other research efforts within the Materials Effects Task Group of NAPAP. Third, the costs associated with the maintenance, repair, and replacement activities related to these components and materials are significant in most building management budgets.

Table 1.1 Building Components and Materials Included in the Life-Cycle Cost Data Base

Building Component	Building Material
Walls	Paint
	Galvanized steel
	Limestone
	Marble
	Masonry mortar
Roofs	Galvanized steel
	Copper
Gutters	Galvanized steel
	Copper
Downspouts	Galvanized steel
	Copper
Fences	Galvanized steel

The 12 component/material combinations given in table 1.1 can be used to define general categories of construction activities that involve either the maintenance, repair, or replacement of the building component. For example, the wall/paint combination suggests the maintenance activity of painting exterior walls. Similarly, the combination of wall/masonry mortar suggests the repair activity of repointing the mortar joints of masonry walls. The remaining combinations suggest other activities such as replacement of gutters and downspouts. Cost estimates for a large number of very specific maintenance, repair, and replacement (MR&R) activities that fall within each of these general categories were collected from published construction cost manuals, as described in section 2. Because there was considerable variation among the cost estimates within some of the 12 general categories, several methods of dividing the categories into smaller groups of more homogeneous data were tested. For example, the cost estimates for painting walls were divided into five groups according to substrate, and the estimates for replacing limestone walls were divided into three groups according to origin of the stone. This process, described in section 3, resulted in the 24 MR&R activity groups listed in table 1.2. Except for painting walls and repointing brick and block walls, the MR&R activities refer to the replacement of the component listed. These MR&R activity groups are used to organize the presentation and analysis of the cost data throughout the remainder of this report. Because the report includes (in appendix B) the complete details of each data point, the reader is able to reorganize the cost data in whatever way best serves a particular research objective.

Table 1.2 Building Components and Maintenance, Repair, and Replacement Activity Groups Used to Organize Cost Data

Building Component	MR&R Activity Group
Walls	Painting Wood
	Painting Masonry
	Painting Concrete
	Painting Stucco
	Painting Metal
	Galvanized Steel
	Indiana Limestone
	Alabama Limestone
	Other Limestone
	Marble
	Repointing Brick
	Repointing Block
Roofs	Galvanized Steel
	Copper
Gutters	Galvanized Steel
	Copper
Downspouts	Galvanized Residential
	Galvanized Commercial
	Copper Residential
	Copper Commercial
Fences	Galvanized Link Fencing
	Galvanized Mesh Fencing
	Galvanized Residential Gates
	Galvanized Commercial Gates

1.3 Overview

The next section of this report describes how the cost data were collected for the 24 MR&R activities listed in table 1.2. The published data sources are discussed and the data collection method is explained.

Section 3 of the report presents summary statistics (sample size, minimum, maximum, median, mean, and coefficient of variation) for each of the 24 MR&R activities. This section also summarizes the results of the analysis of the groupings used and the results of the regression analysis conducted to explain some of the variation within the MR&R activity groups.

Section 4 explains how the cost data presented here are related to the data being produced by other research efforts within NAPAP. Several numerical examples are used to illustrate how the cost data are to be combined with the physical damage functions, the data on the effects of damage on the frequency of MR&R activities, and the materials inventory data to derive estimates of the dollar cost of the damage to common building materials resulting from acid precipitation. Section 5 summarizes the research results and identifies future research needs.

The report concludes with a list of references, a list of other sources of life-cycle cost data, and four appendices. Appendix A contains the Building Inventory Worksheet developed under this project. Appendix B contains the details of each of the 360 data points in the life-cycle cost data base. For each data point, appendix B presents the cost estimate of the MR&R activity, the published data source and page number from which the estimate was derived, and all of the technical specifications given by the published data source. Appendix C presents a table of geographic adjustment factors and describes a method to apply those factors to convert the U.S. average cost estimates of appendix B to their local equivalent values for 156 cities. Appendix D presents methods for adjusting the cost data to take into account the base period, labor type (union or non-union), project type (new or repair and replacement construction), and economies of scale.

2. COST DATA COLLECTION

2.1 Data Sources

A literature search was conducted for reliable life-cycle cost data on the building components and materials listed in table 1.1. Eighteen published sources of relevant information were identified. Three criteria were employed to select the most useful of these 18 sources. The sources had to be (1) standard cost estimating reference sources used throughout the construction industry, (2) updated regularly, and (3) basically consistent with one another. The six published construction cost manuals which met these criteria are listed in table 2.1. The remaining 10 information sources are given in the Other Data Sources listed at the end of the report.

The Berger, Dodge, and Means manuals develop their cost data in the same manner.[1] The cost estimate of any given MR&R activity is constructed from data on the five factors affecting total cost: (1) materials cost, (2) wage rates, (3) crew definition, (4) crew output rate, and (5) overhead and profit rates. Materials costs are updated annually through contacts with product manufacturers and manufacturers' sales representatives. Union wage rates are collected annually from union halls; Berger and Dodge use averages which vary by trade for 20 major U.S. cities, and MEANS REP & REM uses averages which vary by trade for the 30 largest U.S. cities. Crew definitions and output rates are developed for the Dodge and Means manuals based on the professional experience and construction industry contacts of staff estimators and engineers. Berger uses averages of crew definitions and output rates for contractors in 20 cities. Crew definitions and output rates remain the same from year to year unless staff research or reader comments reveal changes in contruction practice. Overhead and profit are derived from a combination of regularly updated and standard data bases for the Berger, Dodge, and Means manuals. Because insurance and tax rates (except social security taxes) vary among states and among construction firms, averages are used. Other overhead expenses usually depend on the size of the firm; averages for these expenses as well as for subcontractors' profit margins are used in the cost manuals.

The Boeckh manual was used for fence and gate cost data only. Boeckh collects total installed costs for fences from contractors and fence suppliers, and then reports the average total cost.[2]

Table 2.1 presents the major characteristics of the six cost manuals. These characteristics are important in determining cost compatibility from source to source. Cost compatibility among sources is necessary to permit the costs found in one manual to be combined with those found in another manual to create a consistent sample of cost estimates.

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[1]Details on how the published sources develop the cost data were obtained directly from the manuals themselves and from the following telephone conversations: Seymour Berger, BERGER, 7/3/85, Percival E. Pereira, DODGE SYSTEMS and DODGE PRICING, 7/8/85, and Melville J. Mossman, MEANS REP & REM and MEANS RES/LT COM, 7/2/85.

[2]Telephone conversation with Terry Ness, BOECKH, 7/8/85.

Table 2.1 Characteristics of Data Sources Used to Develop the Data Base

Characteristic	Data Source					
	BERGER	BOECKH[a]	DODGE SYSTEMS	DODGE PRICING	MEANS REP & REM	MEANS RES/LT COM
Base Period	Mid-84	Jan-82	Early-84	Mid-84	Jan-84	Jan-84
Subcontractor O&P Included	Yes	Yes	Yes	Yes	Yes	Yes
General Contractor O&P Included	No	No	Yes	No	No	No
Project Type	New & Replace	Replace	New	New	Replace	New
Building Project Size ($1000)	>1,000	130	2,540	2,515[b]	250	<400
End-use Sector[c]	Res/ Com/Ind	Res	Res/ Com/Ind	Com	Res/ Com/Ind	Res/ Light Com
Labor Type	Union	Union	Union	Union	Union	Non-Union

SOURCES:

BERGER: Building Cost File, Inc. The 1984 Berger Building & Design Cost File. (Vol. 1: General Construction Trades--Unit Prices). Hicksville, NY: 1984.

BOECKH: E. H. Boeckh Co. Underwriter's Valuation Manual. Milwaukee, WI: American Appraisal Associates, Inc., 1984.

DODGE SYSTEMS: McGraw-Hill Cost Information Systems. 1984 Dodge Construction System Costs. (1984 Construction Cost Information, Vol. 1). Princeton, NJ: 1983.

DODGE PRICING: McGraw-Hill Cost Information Systems. 1984 Dodge Manual for Building Construction Pricing and Scheduling. 19th Annual Edition (1984 Construction Cost Information, Vol. 2). Princeton, NJ: 1983.

MEANS REP & REM: Robert Snow Means Company, Inc. Repair and Remodeling Cost Data: Commercial/Residential 1984. 5th Annual Edition. Kingston, MA: 1984.

MEANS RES/LT COM: Robert Snow Means Company, Inc. Residential/Light Commercial Cost Data 1984. 3rd Annual Edition. Kingston, MA: 1984.

NOTES:

[a] Characteristics listed for BOECKH apply to its residential fence and gate cost data only.

[b] Average of commercial building costs taken from DODGE SYSTEMS, p. 26.

[c] Res = Residential, Com = Commercial, Ind = Industrial

As table 2.1 indicates, five of the six cost manuals use a base year of 1984 for their cost estimates. The cost estimates from the Boeckh manual have a base year of 1982. These costs were converted to a base period of January 1984 using time-location multipliers that Boeckh reports for this purpose.[1] (Since no national averages were given for the Boeckh time multipliers, the multipliers for Massachusetts were used under the assumption that this state is representative of the geographic area of NAPAP interest.) Consequently, all the cost estimates presented in appendix B have a base year of 1984, although the base period (i.e, month) within 1984 varies among the sources. With appropriate conversion factors, the cost estimates could be converted to any common base period desired. Because more cost estimates in this data base are taken from the Means manuals, the factors needed to convert the Berger and Dodge estimates to the Means base period of January 1984 are given and illustrated in appendix D.

The cost estimates reported in the manuals are national average construction costs and may need to be adjusted to account for local cost variations. Because more of the cost estimates presented in this report are derived from the two Means manuals, the Means City Cost Index system is most appropriate for deriving local construction cost estimates from the U.S. average cost estimate. Another reason for using the Means system is that it provides separate indexes for 16 distinct construction divisions. These separate division indexes take into account the variation among divisions in the relative importance of materials versus labor costs. The following construction divisions are most relevant for the MR&R activities discussed in this report: Masonry, Metals, Moisture Protection, and Painting. Appendix C presents a table of geographic indexes for these construction divisions and illustrates how to apply the factors to the cost estimates of appendix B.

It can be seen from table 2.1 that costs from all but one source include overhead and profit of subcontractors only. Costs collected from DODGE SYSTEMS include general contractor overhead and profit as well as subcontractor overhead and profit. Based on an inquiry made of Dodge,[2] ten percent was subtracted from the cost estimates collected from DODGE SYSTEMS in order to approximate costs including subcontractor overhead and profit only.

The project type information given in table 2.1 indicates that some of the manuals focus on construction activities associated with new projects (New) while other manuals address activities associated with repair and replacement projects (Replace). A construction activity associated with a repair and replacement project tends to cost more than the same activity associated with a new construction project for two reasons. First, the subcontractor's overhead and profit rates are higher for a replacement project because a subcontractor working on the smaller replacement project tends to have a lower overall volume of business. Secondly, there are a number of costly tasks that are often required with repair and replacement work, such as dust and noise protection of non-construction areas. Appendix D provides and illustrates the use of percentage amounts that can be applied to the new construction cost estimates of appendix B in order to account for these special repair and replacement cost items. These figures were derived using relative labor and

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[1]BOECKH, pp. HTLM1-HTLM20.

[2]Telephone conversation with Percival E. Pereira, Chief Editor, DODGE SYSTEMS, 10/26/84.

materials costs for the four relevant construction divisions. Table 2.2 presents these labor and materials percentages for the four construction divisions and for a weighted average of all 16 construction divisions.

The six data sources used for this report give cost estimates for subcontracted items of work that are part of a general contractor's project for an entire building or complex of buildings. Subcontracted items of work tend to cost less per unit in large building projects because of economies of scale. Means has developed a method of adjusting costs to take this into account. (The method is presented in appendix D.) Table 2.1 gives the approximate cost of the typical building projects used by each data source, reflecting the sizes of the projects.[1]

As indicated by the "end-use sector" listings given in table 2.1, the construction cost data reported by all of the manuals apply to the types of buildings addressed by the Materials Inventory Survey being conducted by the Materials Effects Task Group. Thus, these data are compatible with the scope of this project.

Unionized labor is the basis of the wage rates reported in all the cost manuals except MEANS RES/LT COM, as can be seen in the bottom row of table 2.1. All the union labor based cost estimates presented in appendix B could be converted to a non-union basis. Appendix D describes and illustrates a conversion method.

2.2 Data Collection Method

A worksheet form was developed for each general MR&R category in order to facilitate collection of relevant data from the manuals. Worksheets for all MR&R categories specified total cost, units in which total cost was reported, cost manual from which the cost data were obtained, with page number, and job specification. The job specification entry was for listing any other details given on the activity. For example, some of the completed worksheets on galvanized steel fences included the length of fence sections in the job specification. Details that were expected to have a significant impact on the cost estimate were listed separately. For example, the worksheet for galvanized steel siding included an entry for gauge. Such details varied from one activity to another.

Once the worksheet forms were developed, the six cost manuals were searched for cost estimates for the MR&R activities of interest, and a worksheet was filled out for each estimate found. Three hundred and sixty cost estimates were collected.

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[1]Project sizes were collected in the following manner. BERGER: Telephone conversation with Seymour Berger, 7/3/85; BOECKH: Average across the 21 residential building types valued on pp. R32-R73; DODGE SYSTEMS: Average across the 47 average building costs, p. 26; DODGE PRICING: Average across the 41 average commercial building costs, DODGE SYSTEMS, p. 26; MEANS REP & REM: p. ii; MEANS RES/LT COM: p. ii.

Table 2.2 Relative Labor and Materials Costs, by Construction Division

Construction Division	Labor Cost ÷ Total Cost (%)	Materials Cost ÷ Total Cost (%)
Masonry	77.3	22.7
Metals	34.7	65.3
Moisture Protection	31.5	68.5
Painting	78.0	22.0
Weighted Average	54.0	46.0

Source: R. S. Means Co., Inc., Building Construction Cost Data 1984 (Kingston, MA: 1984), pp. 323-331.

3. COST DATA PRESENTATION

The cost data collection effort resulted in a data base of 360 MR&R activity cost estimates. Each estimate is derived directly from one of the six published data sources described in section 2. This section first presents descriptive statistics to summarize the cost data for the general MR&R activity categories. Then the sources of cost variation within the general categories are discussed and examined with the statistical techniques of analysis of variance and regression analysis. Each of the 360 cost estimates with its technical specifications as obtained from the published data source is presented in appendix B.

3.1 Summary Statistics for the General MR&R Categories

Table 3.1 reports the summary statistics for 14 general MR&R activity categories. These categories are derived from the 12 component/material combinations given in table 1.1 of section 1 by dividing masonry mortar into the two categories of brick mortar and block mortar and by adding gates as a category distinct from fences. The masonry category must be divided because the data sources use different units of measurement for brick and block: cost estimates for repointing brick mortar are given in dollars per square foot of wall, while those for repointing block mortar are given in dollars per lineal foot of mortar. Gates are listed separately from fences because the data indicate that their costs depend on different factors. Column 1 of the table lists the building component for each activity category and Column 2 describes each activity by giving the material used. Column 3 gives the sample size, that is, the number of individual cost estimates that were used to derive the summary statistics for that activity category. Column 4 gives the physical units of measurement (square feet (SF) or lineal feet (LF)) in which the individual cost estimates and the summary statistics are stated. Columns 5 through 8 present the maximum, minimum, median, and arithmetic mean, respectively, of the cost estimates for each activity category. These four values are given in 1984 dollars per physical unit of measurement. It is interesting to note that the mean and median values are quite close to each other for almost all of the activity categories. This result means that the distributions of the cost estimates within the categories are quite symmetric.

Column 9 of table 3.1 gives the coefficent of variation for each of the categories. This statistic expresses the sample standard deviation as a percent of the sample mean. Because it is stated as a percent it can be compared across categories. For the categories given in table 3.1, galvanized gates exhibit the greatest variation in cost (relative to the mean) with 80 percent, while copper downspouts show the smallest relative variation with only 19 percent.

Table 3.1 Summary Statistics of Cost Data (1984 $) by General MR&R Activity Category

Component (1)	MR&R Activity Category (2)	Sample Size (3)	Units (4)	Maximum ($/unit) (5)	Minimum ($/unit) (6)	Median ($/unit) (7)	Mean ($/unit) (8)	Coefficient of Variation (%) (9)
Walls	Painting	50	SF	0.71	0.09	0.21	0.25	55
	Galvanized Steel	16	SF	4.88	1.46	2.18	2.66	45
	Limestone	79	SF	31.29	8.11	15.10	16.18	34
	Marble	19	SF	35.95	15.86	20.95	23.23	28
	Repointing Brick Mortar	13	SF	3.87	2.56	3.10	3.11	12
	Repointing Block Mortar	4	LF	1.94	0.77	1.31	1.33	44
Roofs	Galvanized Steel	25	SF	4.87	1.37	2.46	2.53	37
	Copper	21	SF	8.74	4.60	6.63	6.44	19
Gutters	Galvanized Steel	16	LF	13.70	2.17	3.47	4.69	67
	Copper	15	LF	16.67	6.40	8.83	9.44	26
Down-spouts	Galvanized Steel	29	LF	7.47	1.36	2.47	2.93	51
	Copper	19	LF	12.24	5.45	8.75	8.46	19
Fences	Galvanized Steel	33	SF	2.90	0.50	1.71	1.59	38
	Galvanized Gates	21	SF	10.26	1.07	3.02	3.48	80
	TOTAL	360						

3.2 Methods of Addressing Variation within MR&R Categories

As column 9 of table 3.1 indicates, the cost estimates in many of the general MR&R activity categories have considerable variation. This variation has two major causes. The first cause relates to the differences inherent in the published cost data sources as explained in section 2. These differences concern such factors as the size of the project (economies of scale), the type of project (new versus replacement), and the labor type employed (union versus non-union). Methods of addressing these sources of variation are discussed in appendix D.

The second cause of variation in the cost estimates concerns the differences in the detailed specifications of the MR&R activity, even within the same published data source. The more detailed the specifications of an activity, the more likely are independent cost estimates of that activity to lead to the same result. Consequently, one method of reducing the variation in the estimates is to provide more technical specification in defining an activity. This has the effect of distributing the 360 cost estimates in the data base into smaller groups of more homogeneous data than the 14 general MR&R activity categories. Carried to its limit, this method could theoretically lead to 360 separate activity groups, each having only one cost estimate. A more moderate implementation of the method was used on the data base for two reasons. First, the level of detail of the technical specifications required by 360 distinct activity groups is far greater than, and inconsistent with, what could be observed in the Materials Inventory Survey data. This is because limited resources permitted observation of the buildings only from the street. Secondly, not all of the technical specifications significantly affect cost. Thus, the selection of the appropriate technical specifications was based on whether they could be observed in the inventory data and whether they significantly affect cost. For example, substrate material meets both of these criteria and was used to group data on the cost of painting walls. Similarly, the type of building--commercial or residential--was used to group data on the cost of downspouts.

For eight of the 14 general MR&R activity categories, it was possible to identify an economically significant technical specification that was reported for every estimate in the category and was expected to be observable in the results of the Materials Inventory Survey. The effect of using these eight specifications to divide the general categories into smaller groups was evaluated with the statistical technique called analysis of variance. The results of this evaluation are summarized in table 3.2.

Column 4 of table 3.2 gives the number of groups that resulted from the application of the eight technical specifications to the eight corresponding general MR&R activity categories. These additional specifications resulted in a total of 26 MR&R activity groups, including those six general categories (indicated by the number 1 in column 4) which were not divided. For each of the eight categories divided into groups, column 5 reports the F-statistic,

Table 3.2 Results of Analysis of Variance to Test the Nominal Significance of Breaking General MR&R Categories into Smaller Groups of More Homogeneous Data

Component (1)	General MR&R Activity Category (2)	Sample Size (3)	Number of Groups (4)	F-Statistic (5)	Nominal Significance Level (%) (6)
Walls	Painting	50	5	3.19	2.2
	Galvanized Steel	16	1	NA	NA
	Limestone	79	3	27.19	0.0
	Marble	19	1	NA	NA
	Repointing Brick	13	1	NA	NA
	Repointing Block	4	1	NA	NA
Roofs	Galvanized Steel	25	1	NA	NA
	Copper	21	1	NA	NA
Gutters	Galvanized Steel	16	2	0.01	92.1
	Copper	15	2	2.94	9.0
Downspouts	Galvanized Steel	29	2	7.68	1.0
	Copper	19	2	8.07	1.1
Fences	Fencing	33	2	63.25	0.0
	Gates	21	2	21.32	0.0
TOTAL		360	26		

NA (Not Applicable) indicates that analysis of variance was not conducted on that general MR&R category because no natural groups were apparent in the specifications given in the published data sources.

which is the standard test of the significance of the new grouping. Column 6 presents the nominal significance level implied by the F-statistic for the sample sizes of the category and of the groups within each category. The nominal significance level indicates how appropriate it is to use the technical specification to create the distinct groups for the data set included in the general MR&R activity category. The word "nominal" means that the data sets analyzed here do not constitute random samples drawn from an identifiable population. Thus, the analytical results are used to describe the data themselves but not to make statistical inferences about a population. Using a required nominal significance level of 5 percent leads to the rejection of the distinction between commercial and residential construction for both galvanized steel gutters and copper gutters. This results in the 24 MR&R activity groups presented in table 3.3. The same summary statistics given for the 14 general MR&R categories in table 3.1 are presented for all 24 MR&R activity groups in table 3.3. These 24 MR&R activity groups form the basis for the organization of the detailed presentation of the cost data in appendix B.

Technical specifications were used above to reduce the variation in the cost estimates within a category by breaking up the category into smaller groups of more homogeneous data. If a technical specification is a continuous variable (such as thickness) rather than a categorical variable (such as type of substrate), then it can be used to explain directly the cost variation within groups (or categories). This approach to addressing the problem of variation relies on the statistical technique called regression analysis. The cost data for the 24 MR&R activity groups were studied to find technical specifications that could serve as continuous variables in a regression equation explaining cost. Reasonable variables were found for 11 of the MR&R activity groups. The analyses were performed using OMNITAB, a statistical analysis program developed at the National Bureau of Standards.[1]

The best method of conducting regression analysis on these (non-random) data would be to weight each data point by a factor to reflect the proportion of the population it represents. Because the scope of this project did not permit the development of such weighting factors, the regression analysis was conducted on the unweighted data to discover whether the explanatory variables do influence cost for these data sets. The MR&R activity groups for which regression analysis was performed fall into three major categories: Unpainted Walls, Gutters and Downspouts, and Roofing.

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[1]For information about OMNITAB, see David Hogben, Sally T. Peavy, and Ruth N. Varner, OMNITAB II User's Reference Manual, NBS Technical Note 552, (Washington, DC: U.S. Government Printing Office, 1971).

Table 3.3 Summary Statistics of Cost Data (1984 $) by Building Component and MR&R Activity Group

Building Component (1)	MR&R Activity Group (2)	Sample Size (3)	Units (4)	Maximum ($/unit) (5)	Minimum ($/unit) (6)	Median ($/unit) (7)	Mean ($/unit) (8)	Coefficient of Variation (%) (9)
Walls	Painting Wood	18	SF	0.47	0.10	0.19	0.21	43
	Painting Masonry	12	SF	0.71	0.09	0.30	0.33	54
	Painting Concrete	8	SF	0.58	0.15	0.32	0.32	42
	Painting Stucco	10	SF	0.46	0.12	0.17	0.21	53
	Painting Metal	2	SF	0.12	0.09	0.11	0.11	20
	Galvanized Steel	16	SF	4.88	1.46	2.18	2.66	45
	Indiana Limestone	40	SF	24.76	8.11	17.59	16.14	33
	Alabama Limestone	9	SF	31.29	19.09	26.15	25.43	17
	Other Limestone	30	SF	17.45	10.82	12.91	13.46	14
	Marble	19	SF	35.95	15.86	20.95	23.23	28
	Repointing Brick Mortar	13	SF	3.87	2.56	3.10	3.11	12
	Repointing Block Mortar	4	LF	1.94	0.77	1.31	1.33	44
Roofs	Galvanized Steel	25	SF	4.87	1.37	2.46	2.53	37
	Copper	21	SF	8.74	4.60	6.63	6.44	19
Gutters	Galvanized Steel	16	LF	13.70	2.17	3.47	4.69	67
	Copper	15	LF	16.67	6.40	8.83	9.44	26
Down-spouts	Galvanized Residential	17	LF	5.73	1.36	1.86	2.35	51
	Galvanized Commercial	12	LF	7.47	1.80	3.50	3.74	40
	Copper Residential	11	LF	9.40	5.45	8.05	7.71	17
	Copper Commercial	8	LF	12.24	8.12	9.18	9.48	14
Fences	Galvanized Link Fencing	25	SF	2.90	1.31	1.84	1.86	20
	Galvanized Mesh Fencing	8	SF	1.07	0.50	0.70	0.74	29
	Galvanized Gates Residential	12	SF	10.26	2.95	4.00	5.18	49
	Galvanized Gates Commercial	9	SF	1.56	1.07	1.11	1.21	14
	TOTAL	360						

UNPAINTED WALLS: The cost data for replacing unpainted walls is stated in dollars per square foot, regardless of the thickness of the limestone or marble panels or the gauge of the galvanized steel. Thickness and gauge are thus the logical candidates to be the explanatory variables in the regression analyses for these MR&R activity groups. Columns 5 and 6 of table 3.4 give the estimated coefficients of the regression equation. The slope coefficient in column 6 indicates how much and in which direction (increase or decrease) the cost per square foot of the wall changes for every added inch of thickness in the limestone or marble (or for every gauge unit of galvanized steel). For example, an additional inch of thickness is estimated to mean an extra cost of $2.40 for Alabama Limestone. The signs of the slope coefficients for Indiana Limestone, Alabama Limestone, and Marble walls are all positive, as expected. The regression for all 30 of the data points for Other Limestone walls yields an unexpected negative slope estimate of -0.94. Such a negative sign implies that thicker walls are less costly to replace than thinner ones. When the same data are divided according to data source (MRR versus DP), the proper sign is obtained for the 18 DODGE PRICING (DP) data points, while the sign remains negative for the 12 MEANS REP & REM (MRR) data points. The unexpected negative sign for the Other Limestone data suggests that cost is influenced by some other variable not included in the regression. The negative value of -0.27 obtained for the slope coefficient for the galvanized steel data is expected since gauge varies inversely with thickness.

Column 8 of table 3.4 reports the R-squared values in percent for each of the regressions. This statistic is interpreted as the percentage of the total variation in the response variable (cost) that is explained by the independent variable (thickness or gauge). The remaining variation in cost is due to other factors that could not be included in the regression. For the Indiana Limestone data set, less than 1 percent of the variation in cost can be explained by thickness. The R-squared values for the other Unpainted Wall regressions indicate that cost is at least partially explained by thickness and gauge.

GUTTERS AND DOWNSPOUTS: The cost per lineal foot of gutters and downspouts is expected to vary as a function of the material required to form the cross section of each component. Since no specifications are given for material thickness, the perimeter of the cross section is a reasonable proxy for this material requirement. For circular downspouts the perimeter of the cross section is equivalent to the circumference of a circle and is computed as the diameter times π (3.1416); for rectangular downspouts the perimeter is computed as the sum of the four sides. The cross-sectional perimeter of gutters, which are open along the top, must be computed differently. For semi-circular gutters the perimeter is one half of the circumference of a circle and is computed as one half the diameter times π; for box-shaped gutters the perimeter is the width plus twice the height of the sides. As table 3.4 indicates, the signs of the estimated slope coefficients are all positive as expected, meaning that an increase in perimeter is more costly. For all but galvanized downspouts the R-squared values indicate that the perimeter explains over 75 percent of the variation in cost.

Table 3.4 Results of Regression Analysis for Unpainted Walls, Gutters and Downspouts, and Roofing

MR&R Activity (1)	Size Sample Size (2)	Explanatory Variable (3)	Units (4)	Constant Coefficient (5)	Slope Coefficient ($/Unit) (6)	Residual Standard Deviation ($) (7)	R-Squared (%) (8)
UNPAINTED WALLS							
Galvanized Steel	16	Gauge	Gauge	9.12	-0.27	0.95	41.1
Indiana Limestone	40	Thickness	Inches	14.52	0.40	5.44	00.8
Alabama Limestone	9	Thickness	Inches	16.62	2.40	3.26	52.0
Other Limestone(MRR)	12	Thickness	Inches	18.01	-0.71	1.64	20.0
Other Limestone(DP)	18	Thickness	Inches	9.38	0.66	0.66	15.7
Marble	19	Thickness	Inches	11.98	7.77	5.60	27.3
GUTTERS AND DOWNSPOUTS							
Galvanized Gutters	16	Perimeter	Inches	-2.87	0.81	1.50	78.4
Copper Gutters	15	Perimeter	Inches	3.89	0.61	1.13	80.8
Galvanized Downspouts	29	Perimeter	Inches	0.67	0.17	1.36	18.4
Copper Downspouts	19	Perimeter	Inches	2.95	0.43	0.56	88.2
ROOFING							
Galvanized Roofing	14†	Gauge	Gauge	4.26	-0.07	0.18	58.5
Copper Roofing	21	Weight	Ounces	2.21	0.24	1.19	11.5

† Data taken from BERGER only

ROOFING: The cost per square foot of roofing is expected to vary as a function of gauge (for galvanized steel) or weight in ounces (for copper). When all 25 data points on steel roofing were included in the regression, the resulting positive slope indicated that cost rises with the gauge of the steel. Since gauge varies inversely with material thickness, this result suggests that a variable not included in the regression is influencing cost. When data from the single largest data source (BERGER, with 14 data points) were analyzed separately, a more meaningful negative slope of -0.07 resulted, with a rather large R-squared value of 58.5 percent. For copper roofing the positive slope of 0.24 makes sense because cost per square foot is likely to vary directly with the weight of the copper. The R-squared value for copper roofing is only 11.5 percent.

4. APPLICATION OF THE COST DATA

This section explains how the cost data can be combined with other data to achieve the primary goal of the Materials Effects Task Group, namely the estimation of the dollar cost of acid deposition damage to buildings. The first subsection discusses the relationship of the life-cycle cost data base presented in this report to the data being developed through other research efforts. The second subsection illustrates with numerical examples how the cost data can be combined with other data to develop dollar estimates of acid deposition damage to buildings.

4.1 Relationship to Other Data

The cost data presented in this report need to be combined with three other types of data to derive dollar damage estimates: physical damage functions, critical damage value data, and building materials inventory data. The physical damage functions are expected to relate the amount of damage, as mass or thickness loss per unit time, to the concentration of acid in the environment. For example, in the case of a galvanized coating over steel, the physical damage function might be expressed as the number of microns of thickness expected to be lost per year as a function of the number of micrograms per cubic meter of a particular acidic component in the environment.

Critical damage value data will specify the amount of damage which will cause MR&R activities to be undertaken. For example, a galvanized coating over steel might need to be replaced once it has lost some number of microns of thickness. When the critical damage values are determined, the physical damage functions can be used to express the amount of time before MR&R activities are required as a function of the concentration of acid in the environment. For example, if at a given concentration of acid the galvanized coating loses 0.5 micron of thickness each year, and the critical damage value is ten microns lost, then it will need to be replaced in 20 years.

The expected time between MR&R activities, when combined with the cost data presented in this report, could be used in a life-cycle cost model to derive estimates of the dollar costs of repairing the damage to building components caused by acid deposition. These estimates would be expressed as the annualized cost of damage per physical unit of the component being considered. For example, damage to painted wood walls would be expressed in dollars per year per square foot of surface area to be painted, while damage to rain gutters would be expressed in dollars per year per lineal foot of guttering to be replaced. In the next subsection, the derivation of such annualized cost damage estimates will be illustrated with numerical examples.

Finally, these unit damage estimates would be combined with building materials inventory data to derive estimates of the total dollar value of acid deposition damage to buildings in the United States. The Building Inventory Worksheet being used to collect these data is presented in appendix A. As can be seen from the Worksheet, the information being collected in this survey will include detailed data on the areas and lineal dimensions of all the major building components and on the significant materials of which they are made. These component/material combinations have been specified so that the areas and lineal dimensions being inventoried for each combination can be directly matched with the corresponding MR&R activities for which cost data are presented in this report.

4.2 Illustrations

This subsection illustrates how the MR&R activity cost data can be combined with data on the expected time between MR&R activities in order to derive a damage estimate, in terms of annualized cost. The MR&R activities are assumed to occur at the end of each service life of the activity. The evaluations in this section are based on the discounted annualized cost A of an expenditure C that is expected to be made in year N.[1]

$$A = \frac{C \cdot i}{(1+d)^{N}-1}$$

where C = the estimated cost of the MR&R activity,
d = the discount rate, and
N = the number of years between each occurrence of the MR&R activity (that is, the expected service life).

The first illustration concerns the cost of maintaining 10,000 square feet of galvanized steel siding. Assume that in environment A, the siding will require replacement every 20 years, while in the more acidic environment B it will last only 16 years. From table 3.3, it can be seen that the average cost of installing galvanized steel siding is $2.66 per square foot. Thus C, the installation cost, can be estimated at $26,600 for 10,000 square feet. If the discount rate is ten percent, then the annualized cost is $464 in environment A and $740 in environment B. Under the assumptions of this illustration, the difference of $276 represents the cost per year of acid rain damage.

The second example examines the effects of acid rain and other pollution on the cost of painting steel buildings. The costs of two different painting systems in three different climates, called Mild, Moderate, and Severe,[2] are compared.

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[1]This formula, sometimes referred to as the Uniform Sinking Fund (USF) Formula, is taken from the American Society for Testing and Materials, "Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems," ASTM E917-83 (Philadelphia, 1983), p. 10.

[2]Data on paint cost and expected service life were taken from A. H. Roebuck and G. H. Brevoort, "Coating Work Costs and Estimating," Materials Performance (January 1983), pp. 43-47. The definitions of Mild, Moderate, and Severe, also from Roebuck and Brevoort, are the following:

Mild = Rural or residential atmosphere. No appreciable industrial fumes or fallout.
Moderate = Industrial plants present. No heavy contamination of industrial fumes or fallout.
Severe = Heavy industrial and chemical plant area with high level contamination of industrial fumes and fallout. Can include proximity to saltwater.

Table 4.1 shows the results of calculations suggested by Roebuck and Brevoort to estimate the cost of painting a building for two alternative coating systems. The total cost is obtained by adding the cost of paint to the labor cost for cleaning and painting the surface. Table 4.2 presents the data on expected service life as reported by Roebuck and Brevoort for each coating system. Using these data, and again assuming that the discount rate is ten percent, the discounted annualized cost for each system can be calculated. Table 4.3 presents these results.

Table 4.1 Application Costs of Coating Systems (1981 $/SF)

	3 Coat Vinyl SSPC6	3 Coat Latex SSPC6
Materials Cost		
Primer	0.094	0.043
Topcoat	0.177	0.039
Finish	0.064	0.039
Materials Total	0.335	0.121
Labor Cost		
Cleaning	0.55	0.55
Painting	0.39	0.39
Labor Total	0.940	0.94
Total Unit Cost	1.275	1.061
Cost/10,000 SF	12,750	10,610

Source: A. H. Roebuck and G. H. Brevoort. "Coating Work Costs and Estimating," Materials Performance (January 1983), pp. 43-47.

Table 4.2 Expected Service Lives (Years) of Coating Systems in Various Atmospheric Conditions

	Mild[1]	Moderate[2]	Severe[3]
Vinyl, SSPC6	7	6	5
Latex, SSPC6	7	5	3

Source: Roebuck and Brevoort

[1] Mild = Rural or residential atmosphere. No appreciable industrial fumes or fallout.

[2] Moderate = Industrial plants present. No heavy contamination of industrial fumes.

[3] Severe = Heavy industrial and chemical plant area with high level contamination of industrial fumes and fallout. Can include proximity to saltwater.

Table 4.3 Discounted Annualized Cost (1981 $/10,000 SF/year) for Coating Systems in Various Atmospheric Conditions (Discount Rate = 10%)

	Mild[1]	Moderate[2]	Severe[3]
Vinyl, SSPC6	1344	1652	2088
Latex, SSPC6	1119	1738	3205

Source: Roebuck and Brevoort

[1] Mild = Rural or residential atmosphere. No appreciable industrial fumes or fallout.

[2] Moderate = Industrial plants present. No heavy contamination of industrial fumes.

[3] Severe = Heavy industrial and chemical plant area with high level contamination of industrial fumes and fallout. Can include proximity to saltwater.

The discounted annualized cost estimates shown in table 4.3 confirm the common-sense notion that different paints are better in different environments. Because latex paint has considerably lower application costs than vinyl ($10,610 versus $12,750) and the same expected service life of 7 years in the Mild climate, latex turns out to be the more economical coating in terms of discounted annualized cost ($1,119 versus $1,344). In the Moderate environment, however, the longer service life of vinyl paint offsets the lower application cost of latex paint, making vinyl the preferred coating in terms of discounted annualized cost ($1,652 versus $1,738). The advantage of vinyl in terms of longer service life becomes even more pronounced in the Severe environment (5 versus 3 years). As a result, the discounted annualized cost of vinyl is much lower than that of latex ($2,088 versus $3,205). Such results will, in general, be sensitive to the discount rate used in the analysis. In this example, however, which coating system is the more economical does not change in any of the three environments for discount rates between two and twenty percent.

Calculations such as these not only can help to select the optimal paint in a given environment, but also can be used to determine the economic effects of a changing environment. For instance, if acid rain causes a once Mild climate (where latex paint is typically used) to become Moderate, the discounted annualized cost of maintaining the latex paint on 10,000 square feet of surface rises by $619 (= $1,738 - $1,119). The substitution of vinyl paint in the Moderate environment would reduce this cost increase to $533 (= $1,652 - $1,119).

5. SUMMARY, CONCLUSIONS, AND RESEARCH NEEDS

5.1 Summary and Conclusions

This report has presented and documented life-cycle cost data for the most economically significant building materials suspected of being damaged by exposure to environmental acid deposition. The data include estimates of the costs of 24 building maintenance, repair, and replacement (MR&R) activities expected to be required more often in an acid environment. The cost data are organized by building component and the material of which the component is made. As explained in section 1, the selection of the components and materials to be included within the scope of this study was based on the economic importance of expected damage to the components and materials. The building components selected under this criterion were walls, roofs, fences, rain gutters, and downspouts. The materials selected include paint, limestone, marble, galvanized steel, copper, and masonry mortar.

A literature search was conducted for sources of useful cost data on the MR&R activities relevant to these building components and materials. The complete results of this search are given in the Cited and the Other References listed below. Six of these references were selected as the sources for the data base because they are widely accepted as cost estimation manuals in the construction industry, they are regularly updated, and they are basically consistent with one another. A detailed description of each of these published cost data sources was provided in section 2.

The search of the six published data sources yielded 360 cost estimates. These estimates were initially organized into 14 general MR&R activity categories. Technical specifications were used to divide these categories further into 26 groups. The technique of analysis of variance was then used to establish the final 24 MR&R activity groups. The results of this data collection and organization effort were summarized in section 3 and are presented in detail in appendix B. Both the arithmetic mean and the median were presented for each of the 24 activities. The mean and the median are almost equal in most cases, which indicates that distributions are generally symmetric. The largest percentage difference between the mean and median occurred in the case of galvanized rain gutters, where the difference was 26 percent of the mean. All but five of the groups had differences of less than 10 percent.

Regression analysis was used to examine variation in the cost estimates within 11 of the MR&R activity groups. For nine of the 11 data sets analyzed, the estimated slope coefficients have algebraic signs that make economic sense. Of these, six have R-squared values indicating that more than 25 percent of the variation in cost is explained by the independent variable. Four of the six have R-squared values in excess of 50 percent.

The relationship of these cost data to other data being developed as part of various research efforts within the Materials Effects Task Group was explained in section 4. These other data include the materials damage functions, the data on the estimated effects of acid deposition damage on the frequency of MR&R activities, and the building materials inventory data. Section 4 also illustrated how the life-cycle cost data presented in this report can be combined with these other data to arrive at an estimate of the annualized dollar cost of acid precipitation damage to buildings.

5.2 Future Research Needs

Two major research efforts remain as natural extensions of this life-cycle cost data project. The first is to expand the cost data base to cover more materials, components, and MR&R activities. These could include building-related components and materials associated with several new damage functions expected to be developed, such as concrete, nonmetal roofing material, building sealants, and roof-mounted equipment, as well as components from other structures such as guard rails and transmission towers. Much of the cost data necessary to include the new building-related materials and components could be obtained from the published data sources already identified, although inclusion of the nonbuilding structures would likely require new sources.

The other effort that should be undertaken is to make the data more accessible to other researchers interested in the assessment of acid deposition damage to common building materials. This goal could be served by the development of a structure for the data base that permits direct data transfer to other computer systems. Another possibility is to develop a system for automating the adjustments to the cost data described in appendices C and D. Such a system could include the adjustments necessary to take into account geographic location, inflation (changes in the base period), labor type, project type, and economies of scale.

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APPENDIX A. BUILDING INVENTORY WORKSHEET FOR PILOT STUDY (1/3/84)

1. Building Identifiers:

1.1 State ________ County ________ Tract/MCD ________

Land use class ________________

Photo ID ____________________

Street address __________________________

____

1.2 UTM Coord. ________ N km ________ E km ________

Geog Coord. ________ lat N ________ long W ________

USGS quad, date ______________

2. Building Description:

2.1 Type of Structure (Check One)

Residential Building

Housing Unit

1 Unit Detached	____
1 Unit Attached	____
2 Units	____
3 and 4 Units	____
5 to 9 Units	____
10 to 19 Units	____
20 to 49 Units	____
50 or More Units	____

Nonhousekeeping (i.e., hotels, motels, dormitories, fraternity and sorority houses, nurses homes, and similar facilities) ____

Nonresidential Building

Office Building ____
Other Commercial ____
Industrial ____
Hospital or Institutional ____
Religious ____
Educational ____
Other Nonresidential ____

Farm (nonresidential) ____

Other (Identify structure ________) ____

Cannot Identify ____

2.2 Gross Lot Dimensions, including extension to center of street (f). ________

2.3 Sketch Building Exterior Plan, indicating (1) dimensions of building exterior (f) and (2) the location of horizontal guttering runs with dashed lines.

2.4 Number of Stories, excluding foundation ______

2.5 Average Wall Height (f) ______
(from grade to roof)

2.6 Approximate Age of Structure (yrs) ______

3. Materials Inventory:

3.1 Walls

(Indicate type of wall by entering the percentages of exterior wall surface area beside each type. Include areas of glazing and doorway under their proper material types.)

3.1.1 Painted Walls (Indicate percentages for each substrate material.)

		Percent (%) of Wall Area of Each Horizontal Section			
		Foundation	1st Story	All Stories Above 1st	Percent (%) of Total Wall Area
3.1.1.1	Wood (excl. stained)	______	______	______	______
3.1.1.2	Steel	______	______	______	______
3.1.1.3	Aluminum	______	______	______	______
3.1.1.4	Masonry	______	______	______	______
3.1.1.5	Concrete	______	______	______	______
3.1.1.6	Stucco	______	______	______	______
3.1.1.7	Other (Identify Material __________)	______	______	______	______
3.1.1.8	Cannot Identify	______	______	______	______
	TOTAL	100	100	100	100

3.1.2 Bare Walls (Indicate percentages for each surface material.)

		Percent (%) of Wall Area of Each Horizontal Section			
		Foundation	1st Story	All Stories Above 1st	Percent (%) of Total Wall Area
3.1.2.1	Masonry (Check Brick _____, Block _____, or Field Stone _____)	______	______	______	______
3.1.2.2	Concrete	______	______	______	______
3.1.2.3	Marble	______	______	______	______
3.1.2.4	Limestone	______	______	______	______
3.1.2.5	Granite	______	______	______	______
3.1.2.6	Galvanized Steel	______	______	______	______
3.1.2.7	Wood (incl. stained)	______	______	______	______
3.1.2.8	Glass	______	______	______	______
3.1.2.9	Vinyl	______	______	______	______
3.1.2.10	Other (Identify Material __________)	______	______	______	______
3.1.2.11	Cannot Identify	______	______	______	______
	TOTAL	100	100	100	100

3.2 Roofs

3.2.1 Configuration: Check whether
Sloped _____ or Flat _____

3.2.2 Area of Exposed Surface (f^2) __________

3.2.3 Exposed Roof Material
(Check Predominant Material)

3.2.3.1 Asphalt Shingle ______
3.2.3.2 Wood ______
3.2.3.3 Painted Metal ______
3.2.3.4 Bare Galvanized ______
3.2.3.5 Tile ______
3.2.3.6 Slate ______
3.2.3.7 Copper ______
3.2.3.8 Other (Identify Material ________________) ______
3.2.3.9 Cannot Identify ______

3.2.4 Roof-Mounted Apparatus	Material [Enter material: painted, bare galvanized, bare aluminum, other (identify material), or cannot identify. For skylights, enter framing material only.]	Number of Items
3.2.4.1 Vents, Flues, Stacks	______________________	_____
3.2.4.2 Skylights	______________________	_____
3.2.4.3 Flashing	______________________	N.A.

3.3 Chimneys

3.3.1 Exposed Surface Area Above Roof (f^2) __________

3.3.2 Enter Material: Painted, Brick, Stone, Other (Identify Material), or Cannot Identify. ______________________

3.4 Rain Gutters

3.4.1 Check if No Gutters ______

3.4.2 Horizontal Runs
Enter Material: Bare Galvanized, Vinyl, Painted, Copper, Other (Identify Material), or Cannot Identify __________

3.4.3 Downspouts
(Enter sum of heights for all downspouts.)

	Downspouts (f)
3.4.3.1 Bare Galvanized	________
3.4.3.2 Vinyl	________
3.4.3.3 Painted	________
3.4.3.4 Copper	________
3.4.3.5 Other (Identify Material ______________)	________
3.4.3.6 Cannot Identify	________

3.5 Fences
(Enter length and height.)

	Length (f)	Height (f)
3.5.1 Bare Galvanized Chain Link	______	______
3.5.2 Bare Galvanized Wire Mesh	______	______
3.5.3 Painted (Enter percent of area that is solid ______%.)	______	______
3.5.4 Masonry (Check Brick ____, Block ____, or Field Stone ____,)	______	______
3.5.5 Unpainted Wood	______	______
3.5.6 Other (Identify Material ______________)	______	______
3.5.7 Cannot Identify	______	______

3.6 Outdoor Accessories. Describe all other accessories (e.g., sheds, storage tanks, handrails, poles, mailboxes, benches, signs, ornamental building features) of the following materials: painted, bare galvanized, bare aluminum, bare steel, copper, concrete, ornamental metal.

Accessory	Material	Exposed Surface Area (f^2)
______________	______________	______________
______________	______________	______________
______________	______________	______________
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APPENDIX B. Life-Cycle Cost Data Base

This appendix presents the entire data base of individual cost estimates on which the summary statistics given in section 3 are based. The cost estimates are organized according to the 24 groups of MR&R activities used in table 3.3. For each activity group, a separate table presents the individual cost estimates ranked in ascending order of cost, with the rank order given in the far left column. The next column(s) to the right present special characteristic(s) of the cost estimate that were available for most of the estimates in that activity group. If the special characteristic was not available for a particular cost estimate, the code NS (for Not Specified) is given. For some activities there are two such special characteristics. The cost estimate itself stated in 1984 dollars per unit of measurement is given in the next column. The unit of measurement used is given in the heading of this column. The column to the right of the cost estimate indicates the published data source of the estimate using a two- or three-letter code to represent one of the six cost data sources discussed in section 2. For reference, the code and the full bibliographic citation of each data source is given in table B.1.

Table B.1 Identification Codes Used for Data Sources in the Data Base

Code	Data Source
BER	Building Cost File, Inc. The 1984 Berger Building & Design Cost File (Vol. 1: General Construction Trades -- Unit Prices). Hicksville, NY: 1984.
BOE	E. H. Boeckh Co. Underwriter's Valuation Manual. Milwaukee, WI: American Appraisal Associates, Inc., 1984.
DS	McGraw-Hill Cost Information Systems. Dodge Construction Systems Costs 1984 (1984 Construction Cost Information, Vol. 1). Princeton, NJ: 1983.
DP	McGraw-Hill Cost Information Systems. 1984 Dodge Manual for Building Construction Pricing and Scheduling, 19th Annual Edition (1984 Construction Cost Information, Vol. 2). Princeton, NJ: 1983.
MRR	Robert Snow Means Company, Inc. Repair and Remodeling Cost Data: Commercial/Residential 1984, 5th Annual Edition. Kingston, MA: 1984.
MRC	Robert Snow Means Company, Inc. Residential/Light Commercial Cost Data 1984, 3rd Annual Edition. Kingston, MA: 1984.

Table B.2

PAINTING WOOD WALLS

ITEM NUM	PAINT TYPE	NUM OF COATS	COST PER COAT ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	LAT	2	$0.10	DP	151	AIRLESS SPRAY
2	LAT	2	$0.11	DP	151	SPRAY
3	LAT	1	$0.13	DP	151	AIRLESS SPRAY
4	LAT	1	$0.14	DP	151	SPRAY
5	VLT	3	$0.15	BER	130	WOOD SIDING
6	NS	3	$0.17	DS	69	BOARD & BATTEN
7	VLT	3	$0.17	BER	130	WOOD SHINGLES
8	OIL	3	$0.18	DP	151	ROLL
9	NS	3	$0.18	DS	69	PLYWOOD OR CEDAR SIDING
10	ENA	3	$0.20	BER	130	WOOD SIDING
11	OIL	2	$0.21	DP	151	ROLL
12	ENA	3	$0.21	BER	130	WOOD SHINGLES
13	OIL	3	$0.25	DP	151	BRUSH
14	OIL	1	$0.26	DP	151	ROLL
15	OIL	2	$0.27	DP	151	BRUSH
16	OIL	1	$0.32	DP	151	BRUSH
17	NS	2	$0.33	MRR	175	PUTTY
18	NS	1	$0.47	MRR	565	PUTTY

PAINT TYPES: LAT = LATEX, ALT = ACRYLIC LATEX, VLT = VINYL LATEX
EPY = EPOXY, ENA = ENAMEL, OIL = OIL, NS = NOT SPECIFIED

Table B.3

PAINTING MASONRY WALLS

ITEM NUM	PAINT TYPE	NUM OF COATS	COST PER COAT ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	VLT	1	$0.09	BER	130	FINISH COAT
2	VLT	2	$0.18	BER	130	
3	VLT	1	$0.18	BER	130	SEALER COAT
4	ENA	1	$0.22	BER	130	HIGH GLOSS ENAMEL, FINISH COAT
5	ENA	2	$0.24	BER	130	HIGH GLOSS ENAMEL
6	EPY	3	$0.29	BER	131	RESIN/ACRYLIC, SPACKLE FINISH
7	ENA	1	$0.31	BER	130	HIGH GLOSS ENAMEL, SEALER COAT
8	EPY	3	$0.35	BER	131	RESIN/ACRYLIC,SPACKLE FINISH,SPRAY
9	NS	2	$0.39	MRR	175	BRUSHWORK, BRICK
10	NS	2	$0.46	MRR	175	BRUSHWORK, BLOCK, FILLER + 2 COATS
11	NS	1	$0.58	MRR	175	BRUSHWORK, BRICK
12	NS	1	$0.71	MRR	175	BRUSHWORK, BLOCK, FILLER + 1 COAT

PAINT TYPES: LAT = LATEX, ALT = ACRYLIC LATEX, VLT = VINYL LATEX
EPY = EPOXY, ENA = ENAMEL, OIL = OIL, NS = NOT SPECIFIED

Table B.4

PAINTING CONCRETE WALLS

ITEM NUM	PAINT TYPE	NUM OF COATS	COST PER COAT ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	VLT	3	$0.15	BER	130	
2	ENA	3	$0.20	BER	130	HIGH GLOSS ENAMEL
3	VLT	1	$0.23	BER	130	FINISH COAT
4	EPY	3	$0.29	BER	131	RESIN/ACRYLIC, SPACKLE FINISH
5	EPY	3	$0.35	BER	131	RESIN/ACRYLIC,SPACKLE FINISH,SPRAY
6	ENA	1	$0.36	BER	130	HIGH GLOSS ENAMEL, FINISH COAT
7	NS	2	$0.39	MRR	175	BRUSHWORK
8	NS	1	$0.58	MRR	175	BRUSHWORK

PAINT TYPES: LAT = LATEX, ALT = ACRYLIC LATEX, VLT = VINYL LATEX
EPY = EPOXY, ENA = ENAMEL, OIL = OIL, NS = NOT SPECIFIED

Table B.5

PAINTING STUCCO WALLS

ITEM NUM	PAINT TYPE	NUM OF COATS	COST PER COAT ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	LAT	2	$0.12	DP	151	SPRAY, MEDIUM TEXTURE STUCCO
2	LAT	1	$0.13	DP	151	SPRAY, MEDIUM TEXTURE STUCCO
3	LAT	2	$0.13	DP	151	ROLL, MEDIUM TEXTURE STUCCO
4	LAT	2	$0.16	DP	151	BRUSH, MEDIUM TEXTURE STUCCO
5	LAT	1	$0.16	DP	151	ROLL, MEDIUM TEXTURE STUCCO
6	NS	3	$0.17	DS	71	
7	NS	3	$0.18	DS	72	BLOCK & STUCCO SYSTEM
8	LAT	1	$0.22	DP	151	BRUSH, MEDIUM TEXTURE STUCCO
9	VLT	1	$0.33	BER	130	FINISH COAT
10	ENA	1	$0.46	BER	130	FINISH COAT

PAINT TYPES: LAT = LATEX, ALT = ACRYLIC LATEX, VLT = VINYL LATEX
EPY = EPOXY, ENA = ENAMEL, OIL = OIL, NS = NOT SPECIFIED

Table B.6

PAINTING METAL WALLS

ITEM NUM	PAINT TYPE	NUM OF COATS	COST PER COAT ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	ALT	2	$0.09	DP	151	CORRUGATED METAL SIDING, SPRAY
2	ALT	1	$0.12	DP	151	CORRUGATED METAL SIDING, SPRAY

PAINT TYPES: LAT = LATEX, ALT = ACRYLIC LATEX, VLT = VINYL LATEX
EPY = EPOXY, ENA = ENAMEL, OIL = OIL, NS = NOT SPECIFIED

Table B.7

GALVANIZED STEEL SIDING

ITEM	GAUGE	COST ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	26	$1.46	BER	82	WITH UNDERLAYMENT, SHINGLES
2	26	$1.47	DS	78	GALV IRON SIDING,CORRUGATED,UNINSUL
3	24	$1.50	BER	82	WITH UNDERLAYMENT, SHINGLES
4	24	$1.65	DS	78	GALV IRON SIDING,CORRUGATED,UNINSUL
5	29	$1.71	MRR	119	CORRUGATED OR RIBBED
6	26	$1.93	MRR	119	CORRUGATED OR RIBBED
7	26	$1.99	BER	82	WITH UNDERLAYMENT, SHINGLES, BOND
8	24	$2.13	BER	82	WITH UNDERLAYMENT, SHINGLES, BOND
9	24	$2.23	MRR	119	CORRUGATED OR RIBBED
10	22	$2.42	MRR	119	CORRUGATED OR RIBBED
11	20	$2.62	MRR	119	CORRUGATED OR RIBBED
12	26	$3.95	BER	82	PREFORMED GALV METAL SIDING,UNINSUL
13	24	$4.02	BER	82	PREFORMED GALV METAL SIDING,UNINSUL
14	22	$4.13	BER	82	PREFORMED GALV METAL SIDING,UNINSUL
15	20	$4.49	BER	82	PREFORMED GALV METAL SIDING,UNINSUL
16	18	$4.88	BER	82	PREFORMED GALV METAL SIDING,UNINSUL

Table B.8

INDIANA LIMESTONE WALLS

ITEM	THCK (IN)	COST ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	4.0	8.11	BER	57	UP TO 50 SF,INDIANA LIMESTONE FACING PANEL,MODULAR DESIGN,LT TEXTURE,BLENDED COLORS
2	4.0	8.43	BER	57	UP TO 50 SF,INDIANA LIMESTONE FACING PANEL,MODULAR DESIGN,DEEP TEXTURE,BLENDED COLORS
3	4.0	8.64	BER	57	UP TO 50 SF,INDIANA LIMESTONE FACING PANEL,MODULAR DESIGN,MEDIUM TEXTURE,BLENDED COLORS
4	4.5	8.74	BER	57	UP TO 60 SF,INDIANA LIMESTONE FACING PANEL,MODULAR DESIGN,LT TEXTURE,BLENDED COLORS
5	4.0	9.00	BER	57	UP TO 50 SF,INDIANA LIMESTONE FACING PANEL,MODULAR DESIGN,LT TEXTURE,PURE COLOR
6	4.5	9.06	BER	57	UP TO 60 SF,INDIANA LIMESTONE FACING PANEL,MODULAR DESIGN,DEEP TEXTURE,BLENDED COLORS
7	5.0	9.09	BER	57	UP TO 70 SF,INDIANA LIMESTONE FACING PANEL,MODULAR DESIGN,LT TEXTURE,BLENDED COLORS
8	4.5	9.27	BER	57	UP TO 60 SF,INDIANA LIMESTONE FACING PANEL,MODULAR DESIGN,MEDIUM TEXTURE,BLENDED COLORS
9	5.0	9.41	BER	57	UP TO 70 SF,INDIANA LIMESTONE FACING PANEL,MODULAR DESIGN,DEEP TEXTURE,BLENDED COLORS
10	5.0	9.62	BER	57	UP TO 70 SF,INDIANA LIMESTONE FACING PANEL,MODULAR DESIGN,MEDIUM TEXTURE,BLENDED COLORS
11	4.5	9.63	BER	57	UP TO 60 SF,INDIANA LIMESTONE FACING PANEL,MODULAR DESIGN,LT TEXTURE,PURE COLOR
12	5.0	9.98	BER	57	UP TO 70 SF,INDIANA LIMESTONE FACING PANEL,MODULAR DESIGN,LT TEXTURE,PURE COLOR
13	2.0	12.34	DP	66	FACING PANELS, INDIANA LIMESTONE, STANDARD
14	2.0	12.99	DP	66	FACING PANELS, INDIANA LIMESTONE, SELECT
15	4.0	14.35	BER	57	ASHLAR VENEER,AVERAGE,INDIANA LIMESTONE,CUSTOM DESIGN,LIGHT TEXTURE,MEDIAN QUALITY & COST
16	3.0	14.96	DP	66	FACING PANELS, INDIANA LIMESTONE, STANDARD
17	3.0	16.00	DP	66	FACING PANELS, INDIANA LIMESTONE, SELECT
18	4.0	16.13	BER	57	ASHLAR VENEER, HIGH QUALITY GRADE, INDIANA LIMESTONE, CUSTOM, LIGHT TEXTURES
19	2.0	17.36	BER	57	UP TO 15 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,MEDIAN QUALITY & COST
20	4.0	17.37	DP	66	FACING PANELS, INDIANA LIMESTONE, SELECT
21	2.0	17.80	BER	57	UP TO 15 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,MEDIUM TEXTURE,MEDIAN QUALITY & COST
22	3.0	18.23	BER	57	UP TO 32 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,MEDIAN QUALITY & COST
23	2.0	18.35	BER	57	UP TO 15 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,DEEP TEXTURE,MEDIAN QUALITY & COST
24	4.0	18.55	DP	66	FACING PANELS, INDIANA LIMESTONE, STANDARD
25	3.0	18.67	BER	57	UP TO 32 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,MEDIUM TEXTURE,MEDIAN QUALITY & COST
26	3.0	19.22	BER	57	UP TO 32 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,DEEP TEXTURE,MEDIAN QUALITY & COST
27	2.0	19.73	BER	57	UP TO 15 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,HIGH QUALITY GRADE
28	4.0	19.83	BER	57	UP TO 50 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,MEDIAN QUALITY & COST
29	4.0	20.27	BER	57	UP TO 50 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,MEDIUM TEXTURE,MEDIAN QUALITY & COST
30	4.0	20.82	BER	57	UP TO 50 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,DEEP TEXTURE,MEDIAN QUALITY & COST
31	3.0	20.84	BER	57	UP TO 32 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,HIGH QUALITY GRADE
32	5.0	21.15	BER	57	UP TO 65 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,MEDIAN QUALITY & COST
33	6.0	21.55	BER	57	UP TO 70 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,MEDIAN QUALITY & COST
34	5.0	21.59	BER	57	UP TO 65 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,MEDIUM TEXTURE,MEDIAN QUALITY & COST
35	6.0	21.99	BER	57	UP TO 70 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,MEDIUM TEXTURE,MEDIAN QUALITY & COST
36	5.0	22.14	BER	57	UP TO 65 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,DEEP TEXTURE,MEDIAN QUALITY & COST
37	6.0	22.54	BER	57	UP TO 70 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,DEEP TEXTURE,MEDIAN QUALITY & COST
38	4.0	22.75	BER	57	UP TO 50 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,HIGH QUALITY GRADE
39	5.0	24.23	BER	57	UP TO 65 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,HIGH QUALITY GRADE
40	6.0	24.76	BER	57	UP TO 70 SF,INDIANA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,HIGH QUALITY GRADE

Table B.9

ALABAMA LIMESTONE WALLS

ITEM	THCK (IN)	COST ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	2.0	19.09	DP	66	FACING PANELS, ALABAMA LIMESTONE
2	4.0	19.74	BER	57	ASHLAR VENEER, MEDIAN QUALITY GRADE, ALABAMA LIMESTONE, CUSTOM, LIGHT TEXTURES
3	3.0	22.31	DP	66	FACING PANELS, ALABAMA LIMESTONE
4	2.0	24.54	BER	57	UP TO 15 SF,ALABAMA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,MEDIAN QUALITY & COST
5	3.0	26.15	BER	57	UP TO 32 SF,ALABAMA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,MEDIAN QUALITY & COST
6	4.0	26.56	DP	66	FACING PANELS, ALABAMA LIMESTONE
7	4.0	28.67	BER	57	UP TO 50 SF,ALABAMA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,MEDIAN QUALITY & COST
8	5.0	30.49	BER	57	UP TO 65 SF,ALABAMA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,MEDIAN QUALITY & COST
9	6.0	31.29	BER	57	UP TO 70 SF,ALABAMA LIMESTONE FACING PANEL,CUSTOM DESIGN,LT TEXTURE,MEDIAN QUALITY & COST

Table B.10

OTHER LIMESTONE WALLS

ITEM	THCK (IN)	COST ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	4.0	10.82	DP	66	FACING PANEL MODULAR UNITS, LIGHT TEXTURE, STANDARD, 4'X10'
2	4.0	11.52	DP	66	FACING PANEL MODULAR UNITS, MEDIUM TEXTURE, STANDARD, 4'X10'
3	4.0	11.54	DP	66	FACING PANEL MODULAR UNITS, DEEP TEXTURE, STANDARD, 4'X10'
4	5.0	11.86	DP	66	FACING PANEL MODULAR UNITS, MEDIUM TEXTURE, STANDARD, 5'X14'
5	5.0	11.86	DP	66	FACING PANEL MODULAR UNITS, LIGHT TEXTURE, STANDARD, 5'X14'
6	4.0	11.97	DP	66	FACING PANEL MODULAR UNITS, LIGHT TEXTURE, SELECT, 4'X10'
7	4.5	12.05	DP	66	FACING PANEL MODULAR UNITS, MEDIUM TEXTURE, STANDARD, 4'X14'
8	4.5	12.10	DP	66	FACING PANEL MODULAR UNITS, LIGHT TEXTURE, STANDARD, 4'X14'
9	5.0	12.22	DP	66	FACING PANEL MODULAR UNITS, DEEP TEXTURE, STANDARD, 5'X14'
10	4.5	12.32	DP	66	FACING PANEL MODULAR UNITS, DEEP TEXTURE, STANDARD, 4'X14'
11	4.0	12.62	DP	66	FACING PANEL MODULAR UNITS, MEDIUM TEXTURE, SELECT, 4'X10'
12	4.0	12.67	DP	66	FACING PANEL MODULAR UNITS, DEEP TEXTURE, SELECT, 4'X10'
13	4.5	12.80	MRR	70	5'X12', TEXTURED FINISH, STICK LIGHT,CUT STONE PANELS
14	4.5	12.90	MRR	70	5'X12', TEXTURED FINISH, RIBBED MEDIUM,CUT STONE PANELS
15	5.0	12.91	DP	66	FACING PANEL MODULAR UNITS, MEDIUM TEXTURE, SELECT, 5'X14'
16	5.0	12.91	DP	66	FACING PANEL MODULAR UNITS, LIGHT TEXTURE, SELECT, 5'X14'
17	4.5	13.00	DP	66	FACING PANEL MODULAR UNITS, LIGHT TEXTURE, SELECT, 4'X14'
18	4.5	13.15	DP	66	FACING PANEL MODULAR UNITS, MEDIUM TEXTURE, SELECT, 4'X14'
19	4.5	13.20	MRR	70	5'X12', TEXTURED FINISH, RIBBED DEEP, CUT STONE PANELS
20	5.0	13.34	DP	66	FACING PANEL MODULAR UNITS, DEEP TEXTURE, SELECT, 5'X14'
21	4.5	13.35	DP	66	FACING PANEL MODULAR UNITS, DEEP TEXTURE, SELECT, 4'X14'
22	4.5	13.40	MRR	70	5'X12', TEXTURED FINISH, SUGARCUBE,CUT STONE PANELS
23	5.0	15.10	MRR	70	5'X14', TEXTURED FINISH, RIBBED MEDIUM,CUT STONE PANELS
24	5.0	15.10	MRR	70	5'X14', TEXTURED FINISH, STICK LIGHT,CUT STONE PANELS
25	3.0	15.15	MRR	70	4'X9', SMOOTH FINISH,CUT STONE PANELS
26	5.0	15.50	MRR	70	5'X14', TEXTURED FINISH, RIBBED DEEP, CUT STONE PANELS
27	2.0	16.25	MRR	70	3'X5', SAWN FINISH,CUT STONE PANELS
28	4.0	17.30	MRR	70	5'X11', SMOOTH FINISH,CUT STONE PANELS
29	2.0	17.40	MRR	70	3'X5', SMOOTH FINISH,CUT STONE PANELS
30	4.5	17.45	MRR	70	5'X14', TEXTURED FINISH, SUGARCUBE,CUT STONE PANELS

Table B.11

MARBLE WALLS

ITEM	THCK (IN)	COST ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	1.25	15.86	DP	67	FACING PANEL, POLISHED, MEZZOTINT
2	1.25	15.91	DP	67	FACING PANEL, POLISHED, SOLAR GRAY
3	1.25	16.54	DP	67	FACING PANEL, POLISHED, WHITE CHEROKEE GEORGIA
4	1.50	17.93	DP	67	FACING PANEL, POLISHED, MEZZOTINT
5	1.50	18.00	DP	67	FACING PANEL, POLISHED, SOLAR GRAY
6	1.25	18.44	DP	67	FACING PANEL, POLISHED, ETOWAH FLEURI PINK TYPE
7	1.50	18.60	DP	67	FACING PANEL, POLISHED, WHITE CHEROKEE GEORGIA
8	1.25	19.06	DP	67	FACING PANEL, POLISHED, GOLDEN VEIN GEORGIA
9	1.50	20.50	DP	67	FACING PANEL, POLISHED, ETOWAH FLEURI PINK TYPE
10	1.00	20.95	BER	57	FACING PANELS, MEDIAN QUALITY & COST
11	1.50	21.15	DP	67	FACING PANEL, POLISHED, GOLDEN VEIN GEORGIA
12	0.75	24.00	MRR	70	FACING PANEL, UNIFORM COLOR
13	1.50	26.59	BER	57	FACING PANELS, MEDIAN QUALITY & COST
14	1.50	27.42	MRR	70	FACING PANEL, UNIFORM COLOR
15	0.75	29.00	MRR	70	FACING PANEL, MULTI-COLOR
16	2.25	30.95	MRR	70	FACING PANEL, UNIFORM COLOR
17	2.25	32.13	BER	57	FACING PANELS, MEDIAN QUALITY & COST
18	1.50	32.42	MRR	70	FACING PANEL, MULTI-COLOR
19	2.25	35.95	MRR	70	FACING PANEL, MULTI-COLOR

Table B.12

REPOINTING BRICK WALLS

ITEM	COST ($/LF)	SOURCE	PAGE	SPECIFICATIONS
1	$2.56	MRR	72	RUNNING BOND,NO STAGING,CUT & REPOINT,SOFT OLD MORTAR
2	$2.66	MRR	72	COMMON BOND,NO STAGING,CUT & REPOINT,SOFT OLD MORTAR
3	$2.77	MRR	72	RUNNING BOND,NO STAGING INCL,REPOINT,MASK&GROUT METHOD
4	$2.83	MRR	72	FLEMISH BOND,NO STAGING,CUT & REPOINT,SOFT OLD MORTAR
5	$2.91	MRR	72	COMMON BOND,NO STAGING INCL,REPOINT,MASK&GROUT METHOD
6	$3.04	MRR	72	FLEMISH BOND,NO STAGING INCL,REPOINT,MASK&GROUT METHOD
7	$3.10	MRR	72	ENGLISH BOND,NO STAGING,CUT & REPOINT,SOFT OLD MORTAR
8	$3.16	MRR	72	RUNNING BOND,NO STAGING,CUT & REPOINT,HARD MORTAR
9	$3.25	BER	59	MEDIAN REPAIRS
10	$3.28	MRR	72	COMMON BOND,NO STAGING,CUT & REPOINT,HARD MORTAR
11	$3.36	MRR	72	ENGLISH BOND,NO STAGING INCL,REPOINT,MASK&GROUT METHOD
12	$3.60	MRR	72	FLEMISH BOND,NO STAGING,CUT & REPOINT,HARD MORTAR
13	$3.87	MRR	72	ENGLISH BOND,NO STAGING,CUT & REPOINT,HARD MORTAR

Table B.13

REPOINTING BLOCK WALLS

ITEM	COST ($/LF)	SOURCE	PAGE	SPECIFICATIONS
1	$0.77	BER	59	SCRAPE & REPOINT WITH FILL & GROUT
2	$0.88	BER	59	MEDIAN REPAIRS, 8 X 16 IN BLOCK
3	$1.73	MRR	72	SOFT OLD MORTAR,NO STAGING,CUT & REPOINT
4	$1.94	MRR	72	HARD MORTAR,NO STAGING,CUT & REPOINT

Table B.14

GALVANIZED STEEL ROOFING

ITEM	GAUGE	COST ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	29	$1.37	MRR	119	CORRUGATED OR RIBBED
2	29	$1.39	DP	110	CORR G.IRON INST.STEEL FRAME,UNINS
3	26	$1.46	DP	110	CORR G.IRON INST.STEEL FRAME,UNINS
4	24	$1.56	DP	110	CORR G.IRON INST.STEEL FRAME,UNINS
5	26	$1.58	MRR	119	CORRUGATED OR RIBBED
6	22	$1.64	DP	110	CORR G.IRON INST.STEEL FRAME,UNINS
7	24	$1.92	MRR	119	CORRUGATED OR RIBBED
8	22	$2.10	MRR	119	CORRUGATED OR RIBBED
9	28	$2.21	BER	85	SHEET METAL, PRESSED PANELS
10	26	$2.26	BER	83	PREFORMED GALV METAL,UNINSULATED
11	28	$2.33	BER	85	SHEET METAL, STANDING SEAM
12	26	$2.37	BER	85	SHEET METAL, STANDING SEAM
13	24	$2.46	BER	83	PREFORMED GALV METAL,UNINSULATED
14	26	$2.49	BER	85	SHEET METAL, PRESSED PANELS
15	24	$2.53	BER	85	SHEET METAL, PRESSED PANELS
16	22	$2.57	BER	83	PREFORMED GALV METAL,UNINSULATED
17	28	$2.65	BER	85	SHEET METAL, BATTEN SEAM
18	22	$2.70	BER	85	SHEET METAL, PRESSED PANELS
19	26	$2.78	BER	85	SHEET METAL, BATTEN SEAM
20	24	$2.81	BER	85	SHEET METAL, BATTEN SEAM
21	20	$2.88	BER	83	PREFORMED GALV METAL,UNINSULATED
22	18	$3.21	BER	83	PREFORMED GALV METAL,UNINSULATED
23	NS	$4.40	DP	112	ZINC SHEET METL,STANDING SEAM,18 OZ
24	NS	$4.59	DP	112	ZINC SHEET METL,STANDING SEAM,20 OZ
25	NS	$4.87	DP	112	ZINC SHEET METAL, BATTEN SEAM,18 OZ

NS = NOT SPECIFIED

Table B.15

COPPER ROOFING

ITEM	SEAM	WEIGHT (OZ)	COST ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	FLAT	16	$4.60	MRR	120	OVER 10 SQUARES, 115 LB/SQUARE
2	STAN	16	$4.60	MRR	120	OVER 10 SQUARES, 125 LB/SQUARE
3	STAN	18	$5.00	MRR	120	OVER 10 SQUARES, 140 LB/SQUARE
4	BATT	16	$5.05	MRR	120	OVER 10 SQUARES, 130 LB/SQUARE
5	FLAT	20	$5.30	MRR	120	OVER 10 SQUARES, 145 LB/SQUARE
6	STAN	20	$5.50	MRR	120	OVER 10 SQUARES, 150 LB/SQUARE
7	BATT	18	$5.55	MRR	120	OVER 10 SQUARES, 145 LB/SQUARE
8	BATT	16	$5.69	DP	112	
9	BATT	20	$5.80	MRR	120	OVER 10 SQUARES, 160 LB/SQUARE
10	FLAT	16	$6.31	DP	112	
11	FLAT	16	$6.63	BER	84	
12	BATT	20	$6.70	DP	112	
13	STAN	16	$6.85	BER	84	
14	FLAT	20	$7.00	BER	84	
15	FLAT	20	$7.23	DP	112	
16	BATT	16	$7.25	BER	84	
17	FLAT	18	$7.37	BER	84	
18	STAN	18	$7.54	BER	84	
19	STAN	20	$8.23	BER	84	
20	BATT	18	$8.30	BER	84	
21	BATT	20	$8.74	BER	84	

SEAM TYPES: STAN = STANDING, BATT = BATTEN, FLAT = FLAT.

Table B.16

GALVANIZED GUTTERS

ITEM	SIZE (IN)*	COST ($/LF)	SOURCE	PAGE	SPECIFICATIONS
1	5	$ 2.17	MRC	321	HALF ROUND OR BOX, 28 GA
2	5	$ 2.32	MRC	321	HALF ROUND OR BOX, 26 GA, STOCK
3	6	$ 2.40	MRC	321	HALF ROUND OR BOX, 26 GA, STOCK
4	5	$ 2.90	MRR	126	HALF ROUND OR BOX, 28 GA
5	5	$ 3.06	MRR	126	HALF ROUND OR BOX, 26 GA, STOCK
6	6	$ 3.13	MRR	126	HALF ROUND OR BOX, 26 GA, STOCK
7	4	$ 3.24	DP	113	
8	4	$ 3.47	BER	86	
9	6	$ 3.47	DP	113	
10	5	$ 3.74	BER	86	
11	6	$ 4.05	BER	86	
12	4	$ 4.70	BER	87	
13	6	$ 5.36	BER	87	
14	3X4	$ 7.92	BER	87	
15	4X6	$ 9.44	BER	87	
16	6X8	$13.70	BER	87	

*SIZES WITH ONE DIMENSION SPECIFY THE DIAMETER;
SIZES WITH TWO DIMENSIONS SPECIFY THE HEIGHT AND WIDTH.

Table B.17

COPPER GUTTERS

ITEM	SIZE (IN)*	COST ($/LF)	SOURCE	PAGE	SPECIFICATIONS
1	4	$ 6.40	MRR	125	16 OZ, HALF ROUND, STOCK UNITS
2	5	$ 6.70	MRR	125	16 OZ, HALF ROUND, STOCK UNITS
3	4	$ 7.55	MRR	125	K TYPE GUTTER, STOCK
4	6	$ 7.80	MRR	125	16 OZ, HALF ROUND, STOCK UNITS
5	4	$ 7.92	DP	113	16 OZ
6	5	$ 8.65	MRR	125	K TYPE GUTTER, STOCK
7	4	$ 8.70	BER	87	
8	4	$ 8.83	BER	86	18 OZ
9	3X4	$ 9.65	BER	87	
10	5	$ 9.97	BER	86	18 OZ
11	6	$10.18	DP	113	16 OZ
12	6	$10.49	BER	87	
13	6	$10.66	BER	86	18 OZ
14	4X6	$11.37	BER	87	
15	6X8	$16.67	BER	87	

*SIZES WITH ONE DIMENSION SPECIFY THE DIAMETER;
SIZES WITH TWO DIMENSIONS SPECIFY THE HEIGHT AND WIDTH.

Table B.18

GALVANIZED DOWNSPOUTS ON RESIDENTIAL BUILDINGS

ITEM	SIZE (IN)*	COST ($/LF)	SOURCE	PAGE	SPECIFICATIONS
1	2	$1.36	MRC	318	CORRUGATED, 28 GA
2	3	$1.36	MRC	318	CORRUGATED, 28 GA
3	2X3	$1.38	MRC	318	PLAIN, 28 GA
4	2X3	$1.42	MRC	318	CORRUGATED, 28 GA
5	2	$1.82	MRR	121	CORRUGATED, 28 GA
6	3	$1.82	MRR	121	CORRUGATED, 28 GA
7	2X3	$1.85	MRR	121	PLAIN, 28 GA
8	3X4	$1.86	MRC	318	CORRUGATED, 28 GA
9	3X4	$1.86	MRC	318	PLAIN, 28 GA
10	2X3	$1.88	MRR	121	CORRUGATED, 28 GA
11	2X3	$2.15	DP	114	
12	3X4	$2.37	DP	114	
13	3X4	$2.47	MRR	121	PLAIN, 28 GA
14	3X4	$2.47	MRR	121	CORRUGATED, 28 GA
15	2X3	$3.97	BER	86	
16	3X4	$4.21	BER	86	
17	3	$5.73	DP	114	

*SIZES WITH ONE DIMENSION SPECIFY THE DIAMETER;
SIZES WITH TWO DIMENSIONS SPECIFY THE HEIGHT AND WIDTH.

Table B.19

GALVANIZED DOWNSPOUTS ON COMMERCIAL BUILDINGS

ITEM	SIZE (IN)*	COST ($/LF)	SOURCE	PAGE	SPECIFICATIONS
1	4	$1.80	MRC	318	CORRUGATED, 28 GA
2	4	$2.41	MRR	121	CORRUGATED, 28 GA
3	5	$2.77	MRR	121	CORRUGATED, 28 GA
4	5	$2.97	MRR	121	CORRUGATED, 26 GA
5	4	$3.05	BER	86	
6	5	$3.43	BER	86	
7	6	$3.58	MRR	121	CORRUGATED, 28 GA
8	6	$3.69	BER	86	
9	6	$3.73	MRR	121	CORRUGATED, 26 GA
10	4X4	$4.66	BER	86	
11	4X6	$5.37	BER	86	
12	4	$7.47	DP	114	

*SIZES WITH ONE DIMENSION SPECIFY THE DIAMETER;
SIZES WITH TWO DIMENSIONS SPECIFY THE HEIGHT AND WIDTH.

Table B.20

COPPER DOWNSPOUTS ON RESIDENTIAL BUILDINGS

ITEM	SIZE (IN)*	COST ($/LF)	SOURCE	PAGE	SPECIFICATIONS
1	2	$5.45	MRR	120	16 OZ, STOCK
2	3	$6.12	DP	114	16 OZ
3	3	$6.60	MRR	120	16 OZ, STOCK
4	2X3	$6.95	MRR	121	CORRUGATED, STOCK
5	2X3	$7.10	MRR	121	PLAIN, STOCK
6	2X3	$8.05	DP	114	16 OZ
7	2X3	$8.16	BER	86	
8	3X4	$8.75	MRR	121	PLAIN, STOCK
9	3X4	$9.13	BER	86	
10	3X4	$9.15	MRR	121	CORRUGATED, STOCK
11	3X4	$9.40	DP	114	16 OZ

*SIZES WITH ONE DIMENSION SPECIFY THE DIAMETER;
SIZES WITH TWO DIMENSIONS SPECIFY THE HEIGHT AND WIDTH.

Table B.21

COPPER DOWNSPOUTS ON COMMERCIAL BUILDINGS

ITEM	SIZE (IN)*	COST ($/LF)	SOURCE	PAGE	SPECIFICATIONS
1	4	$8.12	DP	114	16 OZ
2	4	$8.28	BER	86	18 OZ
3	4	$8.75	MRR	120	16 OZ, STOCK
4	5	$9.01	BER	86	18 OZ
5	5	$9.35	MRR	120	16 OZ, STOCK
6	6	10.01	BER	86	18 OZ
7	4X4	10.10	BER	86	
8	4X6	12.24	BER	86	

*SIZES WITH ONE DIMENSION SPECIFY THE DIAMETER;
SIZES WITH TWO DIMENSIONS SPECIFY THE HEIGHT AND WIDTH.

Table B.22

GALVANIZED STEEL CHAIN LINK FENCING

ITEM	HGHT (FT)	GA	COST ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	4.0	11	1.31	MRR	45	RESIDENTIAL, 1 5/8" LINE POST @ 10' O.C., 1 3/8" TOP RAIL. GATE 3' WIDE, 1 3/8" FRAME
2	6.0	NS	1.39	BOE	R77	RESIDENTIAL. WALK-IN GATES.
3	3.0	11	1.41	MRR	45	RESIDENTIAL, 1 5/8" LINE POST @ 10' O.C., 1 3/8" TOP RAIL. GATE 3' WIDE, 1 3/8" FRAME
4	5.0	NS	1.43	BOE	R77	RESIDENTIAL. WALK-IN GATES.
5	6.0	11	1.53	BER	30	STD RES.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
6	7.0	11	1.54	BER	30	STD RES.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
7	4.0	NS	1.57	BOE	R77	RESIDENTIAL. WALK-IN GATES.
8	3.0	NS	1.69	BOE	R77	RESIDENTIAL. WALK-IN GATES.
9	5.0	11	1.71	BER	30	STD RES.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
10	12.0	9	1.73	BER	29	STD IND.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
11	10.0	9	1.76	BER	29	STD IND.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
12	8.0	9	1.83	BER	29	STD IND.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
13	6.0	9	1.84	BER	29	STD IND.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
14	7.0	9	1.85	BER	29	STD IND.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
15	4.0	9	1.88	DP	34	RESIDENTIAL.INCLUDES EXCAVATION AND CONCRETE FOR POSTS INSTALLED IN EARTH. 3' WIDE GATE.
16	6.0	9	1.88	DP	34	INCLUDES EXCAVATION AND CONCRETE FOR POSTS INSTALLED IN EARTH. 2" POSTS 10' O.C.
17	8.0	9	1.88	BOE	518	
18	4.0	11	1.89	BER	30	STD RES.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
19	3.5	11	2.08	BER	30	STD RES.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
20	5.0	9	2.08	BER	29	STD IND.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
21	3.0	9	2.08	DP	34	RESIDENTIAL.INCLUDES EXCAVATION AND CONCRETE FOR POSTS INSTALLED IN EARTH. 3' WIDE GATE.
22	4.0	9	2.29	BER	29	STD IND.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
23	3.0	11	2.38	BER	30	STD RES.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
24	3.5	9	2.54	BER	29	STD IND.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE
25	3.0	9	2.90	BER	29	STD IND.ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,GATE HARDWARE

NS = NOT SPECIFIED

Table B.23

GALVANIZED STEEL MESH FENCING

ITEM	HGHT (FT)	GA	COST ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	5.0	12	0.50	DP	35	2"X4" MESH. INCLUDES EXCAVATION AND CONCRETE FOR POSTS INSTALLED IN EARTH.
2	5.0	14	0.51	DP	35	1"X2" MESH. INCLUDES EXCAVATION AND CONCRETE FOR POSTS INSTALLED IN EARTH.
3	3.0	12	0.58	DP	35	2"X4" MESH. INCLUDES EXCAVATION AND CONCRETE FOR POSTS INSTALLED IN EARTH.
4	3.0	14	0.69	DP	35	1"X2" MESH. INCLUDES EXCAVATION AND CONCRETE FOR POSTS INSTALLED IN EARTH.
5	5.0	14	0.71	BER	30	1"X2" MESH, 6' O.C. POSTS
6	3.0	12	0.83	BER	30	2"X4" MESH, 6' O.C. POSTS
7	3.0	14	0.99	BER	30	1"X2" MESH, 6' O.C. POSTS
8	3.0	12	1.07	BER	30	1"X2" MESH, 6' O.C. POSTS

Table B.24

RESIDENTIAL GALVANIZED STEEL CHAIN LINK GATES

ITEM	HGHT (FT)	WDTH (FT)	GA	COST ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	6.0	3	11	2.95	BER	30	RES, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
2	7.0	3	11	3.02	BER	30	RES, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
3	5.0	3	11	3.21	BER	30	RES, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
4	4.0	3	11	3.41	MRR	45	RES, 1 5/8" LINE POST @ 10' O.C., 1 3/8" TOP RAIL, 1 3/8" FRAME
5	4.0	3	11	3.47	BER	30	RES, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
6	3.5	3	11	3.77	BER	30	RES, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
7	3.0	3	11	4.22	MRR	45	RES, 1 5/8" LINE POST @ 10' O.C., 1 3/8" TOP RAIL, 1 3/8" FRAME
8	3.0	3	11	4.25	BER	30	RES, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
9	4.0	3	NS	6.99	BOE	R77	RES
10	3.0	3	NS	7.98	BOE	R77	RES
11	4.0	3	9	8.63	DP	34	RES, INCLUDES EXCAVATION AND CONCRETE FOR POSTS INSTALLED IN EARTH
12	3.0	3	9	10.26	DP	34	RES, INCLUDES EXCAVATION AND CONCRETE FOR POSTS INSTALLED IN EARTH

NS = NOT SPECIFIED

Table B.25

COMMERCIAL GALVANIZED STEEL CHAIN LINK GATES

ITEM	HGHT (FT)	WDTH (FT)	GA	COST ($/SF)	SOURCE	PAGE	SPECIFICATIONS
1	6.0	10	9	1.07	BER	29	IND, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
2	7.0	10	9	1.09	BER	29	IND, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
3	12.0	10	9	1.10	BER	29	IND, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
4	10.0	10	9	1.10	BER	29	IND, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
5	8.0	10	9	1.11	BER	29	IND, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
6	5.0	10	9	1.17	BER	29	IND, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
7	4.0	10	9	1.27	BER	29	IND, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
8	3.5	10	9	1.38	BER	29	IND, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE
9	3.0	10	9	1.56	BER	29	IND, ROUND POST,GATE FRAME BRACE,RAIL,STRETCHER BAR,TRUSS ROD&TENSION WIRE,2X2MESH,HARDWARE

APPENDIX C: Adjusting for Local Variations in Costs

Each cost estimate given in the tables of appendix B represents average construction costs for the United States. Because costs vary from place to place, however, a method is needed for adjusting the cost estimates to take local cost variations into account. This appendix presents and illustrates such a method based on Means.[1]

The method consists of four steps:

Step 1: Find the cost estimate in appendix B.

Step 2: Find the construction division for the MR&R activity in table C.1.

Step 3: Find the cost index for the relevant city and construction division in table C.2.

Step 4: Use the index from step 3 to adjust the cost estimate.

As an example, suppose one wants to convert a U.S. average cost estimate for installing galvanized steel siding to the equivalent cost in New Haven, Connecticut.

Step 1: Find the relevant cost estimate.

Table B.7, item 11, reports the cost of installing 20 gauge corrugated steel siding as $2.62/SF.[2] If some other kind of siding were to be installed, a different cost estimate would be used.

Step 2: Determine the construction division of the MR&R activity.

Table C.1 assigns each of 24 MR&R activities to a particular construction division. The division for galvanized steel siding (walls) is Moisture Protection.

Step 3: Find the cost index for the relevant city and construction division.

Table C.2 gives the cost indices for 156 U.S. cities for four construction divisions: Masonry, Metals, Moisture Protection, and Painting. (A Weighted Average, which includes construction divisions not considered in this report, is also provided. It may be useful if a particular MR&R activity does not fall into one of the four divisions given here.) The index for Moisture Protection in New Haven, Connecticut is 89.7.

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[1]Means, Building Construction Cost Data 1984, pp. 323-331.

[2]This cost estimate is from MEANS REP & REM, p. 119.

Step 4: Adjust the cost estimate.

The cost index states the average cost of work in a certain construction division in a given city as a percent of the average cost for the United States as a whole. Thus, to convert a U.S. average cost estimate from appendix B to a cost estimate for a particular city, multiply the U.S. cost by the index obtained in step 3 and divide by 100:

$$\text{City Cost} = \text{U.S. cost} \times \text{index}/100.$$

In our example, the cost of installing the 20 gauge corrugated steel siding in New Haven is \$2.35/SF (= \$2.62 x 89.7/100).

Table C.1 Construction Divisions for Building Components and MR&R Activity Groups

Building Component (1)	MR&R Activity Group (2)	Construction Division (3)
Walls	Painting Wood	Painting
	Painting Masonry	Painting
	Painting Concrete	Painting
	Painting Stucco	Painting
	Painting Metal	Painting
	Galvanized Steel	Moisture Protection
	Indiana Limestone	Masonry
	Alabama Limestone	Masonry
	Other Limestone	Masonry
	Marble	Masonry
	Repointing Brick Mortar	Masonry
	Repointing Block Mortar	Masonry
Roofs	Galvanized Steel	Moisture Protection
	Copper	Moisture Protection
Gutters	Galvanized Steel	Moisture Protection
	Copper	Moisture Protection
Down-spouts	Galvanized Residential	Moisture Protection
	Galvanized Commercial	Moisture Protection
	Copper Residential	Moisture Protection
	Copper Commercial	Moisture Protection
Fences	Galvanized Link Fencing	Metals
	Galvanized Mesh Fencing	Metals
	Galvanized Gates Residential	Metals
	Galvanized Gates Commercial	Metals

Source: MEANS REP & REM, pp. xxii-xxiii and 383.

Table C.2 Geographic Adjustment Factors Used to Convert U.S. Average Cost Estimates to Their Local Equivalent Values for 156 Cities, by Type of Construction Activity

	Construction Activity				
State/City	Painting	Masonry	Moisture Protection	Metals	Weighted Average
Alabama					
Birmingham	87.7	75.6	81.6	90.8	84.6
Huntsville	85.3	80.9	87.0	93.4	88.2
Mobile	89.9	83.4	85.5	89.8	90.3
Montgomery	85.8	75.4	84.2	90.0	85.5
Alaska					
Anchorage	142.7	149.9	117.1	121.8	134.4
Arizona					
Phoenix	93.1	97.8	93.0	97.7	97.7
Tucson	94.8	93.7	103.0	94.5	97.3
Arkansas					
Fort Smith	83.5	80.2	81.2	95.5	86.6
Little Rock	86.2	80.7	82.6	97.6	88.7
California					
Anaheim	122.6	122.6	114.9	106.0	112.1
Bakersfield	117.3	114.0	95.7	102.2	107.0
Fresno	119.7	119.3	108.6	102.8	111.7
Los Angeles	119.9	119.4	114.3	110.0	111.2
Oxnard	117.3	119.5	102.1	109.9	112.6
Riverside	118.8	119.3	99.1	105.9	110.3
Sacramento	125.8	124.0	98.5	116.0	115.0
San Diego	126.0	117.1	104.3	104.1	110.2
San Francisco	138.7	134.3	101.4	111.4	122.5
Santa Barbara	122.0	120.9	99.9	105.0	113.0
Stockton	123.4	115.9	98.5	102.1	112.3
Vallejo	130.4	128.3	100.2	101.8	115.8
Colorado					
Colorado Springs	90.2	99.1	88.4	95.0	96.1
Denver	107.8	106.5	103.0	97.2	101.6
Connecticut					
Bridgeport	98.0	94.8	97.9	92.6	98.0
Hartford	104.8	93.7	99.1	93.8	98.1
New Haven	98.5	100.3	89.7	88.4	97.2
Stamford	99.2	97.8	89.3	89.0	97.9
Waterbury	94.8	96.6	89.1	89.7	95.9
Delaware					
Wilmington	87.1	97.0	91.2	94.3	99.4
D.C.					
Washington	103.3	93.4	100.2	98.3	95.4

Table C.2 Geographic Adjustment Factors Used to Convert U.S. Average Cost Estimates to Their Local Equivalent Values for 156 Cities, by Type of Construction Activity (Continued)

	Construction Activity				
State/City	Painting	Masonry	Moisture Protection	Metals	Weighted Average
Florida					
Ft. Lauderdale	87.2	88.5	85.8	87.9	90.9
Jacksonville	83.4	75.5	84.4	90.9	87.9
Miami	90.5	85.1	86.2	89.1	91.9
Orlando	81.6	71.4	81.3	85.6	85.3
Tampa	86.3	85.2	95.8	97.5	93.0
Georgia					
Atlanta	94.9	83.3	88.1	100.0	90.3
Columbus	78.6	61.2	85.1	89.1	83.1
Macon	86.4	73.5	86.1	88.4	86.1
Savannah	82.7	77.1	86.2	95.5	87.7
Hawaii					
Honolulu	112.9	107.0	105.1	106.0	109.1
Idaho					
Boise	95.9	94.8	102.0	94.0	95.7
Illinois					
Chicago	93.4	99.1	101.4	92.3	97.7
Peoria	102.4	100.6	94.0	94.0	97.9
Rockford	101.3	100.3	104.5	105.2	101.2
Springfield	98.7	99.0	98.1	94.7	98.4
Indiana					
Evansville	92.9	97.6	90.4	94.4	97.6
Fort Wayne	95.2	90.0	95.1	98.4	94.7
Gary	107.9	105.1	95.6	97.1	103.4
Indianapolis	88.4	94.6	106.0	99.9	97.5
South Bend	97.4	96.4	92.1	101.0	98.5
Terre Haute	99.5	94.6	92.3	93.2	96.0
Iowa					
Davenport	98.7	100.0	90.1	92.7	98.9
Des Moines	92.6	91.2	87.9	89.6	94.4
Kansas					
Topeka	94.1	86.6	92.8	100.1	92.7
Wichita	87.1	83.6	91.1	96.0	90.8
Kentucky					
Lexington	91.0	89.1	86.0	88.5	93.7
Louisville	81.7	90.6	87.1	85.8	95.0

Table C.2 Geographic Adjustment Factors Used to Convert U.S. Average Cost Estimates to Their Local Equivalent Values for 156 Cities, by Type of Construction Activity (continued)

	Construction Activity				
State/City	Painting	Masonry	Moisture Protection	Metals	Weighted Average
Louisiana					
Baton Rouge	78.6	95.4	98.2	99.0	93.3
New Orleans	91.0	87.5	90.7	96.7	92.6
Shreveport	79.2	86.5	84.4	90.5	89.6
Maine					
Lewiston	80.7	81.0	84.6	91.6	88.5
Portland	85.3	80.4	83.5	100.3	89.1
Maryland					
Baltimore	87.4	85.8	89.6	95.5	93.1
Massachusetts					
Boston	100.1	104.0	116.1	108.2	104.8
Lawrence	101.6	100.1	98.6	97.8	100.3
Lowell	102.8	103.0	99.3	95.5	100.6
Springfield	98.5	94.7	95.9	96.5	96.5
Worcester	100.1	97.6	99.1	97.1	99.2
Michigan					
Ann Arbor	109.7	102.3	96.3	98.5	102.5
Detroit	108.5	101.4	105.4	101.6	102.9
Flint	92.0	102.2	90.4	97.2	98.8
Grand Rapids	92.8	92.4	105.2	100.6	95.5
Kalamazoo	98.0	94.5	90.6	99.3	96.1
Lansing	103.1	102.1	108.8	108.6	102.0
Saginaw	103.8	99.2	95.6	103.0	99.4
Minnesota					
Duluth	96.9	97.6	93.5	101.7	97.0
Minneapolis	102.1	100.8	98.3	94.5	100.1
Mississippi					
Jackson	82.8	80.7	82.0	84.2	86.3
Missouri					
Kansas City	98.1	95.9	96.4	102.4	98.9
St. Louis	95.7	96.8	97.3	99.5	97.8
Montana					
Billings	87.9	92.6	97.0	95.3	95.5
Great Falls	93.8	91.8	97.9	89.5	94.7
Nebraska					
Lincoln	87.1	86.0	86.7	86.4	91.4
Omaha	90.1	92.2	100.7	103.4	96.0

Table C.2 Geographic Adjustment Factors Used to Convert U.S. Average Cost Estimates to Their Local Equivalent Values for 156 Cities, by Type of Construction Activity (continued)

	Construction Activity				
State/City	Painting	Masonry	Moisture Protection	Metals	Weighted Average
Nevada					
Las Vegas	114.3	113.7	97.3	111.6	107.9
Reno	118.7	118.4	107.2	103.8	109.2
New Hampshire					
Manchester	92.5	87.1	91.8	95.0	91.7
Nashua	89.6	87.8	99.2	88.0	91.9
New Jersey					
Jersey City	97.9	103.6	113.3	102.0	103.2
Newark	102.0	105.0	106.4	99.8	102.7
Paterson	102.5	104.4	111.0	98.6	103.0
Trenton	103.6	100.0	101.6	99.1	100.1
New Mexico					
Albuquerque	90.1	82.1	93.0	100.1	93.8
New York					
Albany	95.5	89.7	101.3	95.3	93.7
Binghamton	89.7	85.6	95.6	95.5	90.8
Buffalo	106.1	107.7	104.4	108.0	105.2
New York	103.8	116.8	104.5	110.6	111.8
Rochester	96.8	98.1	106.4	99.9	99.1
Syracuse	95.1	94.2	95.7	98.2	95.6
Utica	96.1	86.6	94.5	99.6	94.1
Yonkers	112.1	112.9	109.3	106.5	108.2
North Carolina					
Charlotte	72.3	71.4	81.3	92.4	83.3
Greensboro	71.7	74.6	80.9	86.5	82.5
Raleigh	71.2	70.8	80.8	86.9	82.8
Ohio					
Akron	106.0	99.7	101.9	101.8	101.1
Canton	96.3	98.8	101.0	98.8	98.1
Cincinnati	94.6	94.6	101.8	97.0	98.5
Cleveland	114.5	111.8	107.4	104.6	106.8
Columbus	101.1	94.5	96.2	99.7	97.8
Dayton	99.1	93.2	101.0	99.8	99.2
Lorain	117.7	105.6	103.7	101.9	103.0
Toledo	109.9	107.3	97.9	101.6	105.1
Youngstown	100.4	98.0	102.5	98.9	99.2

Table C.2 Geographic Adjustment Factors Used to Convert U.S. Average Cost Estimates to Their Local Equivalent Values for 156 Cities, by Type of Construction Activity (continued)

	Construction Activity				
State/City	Painting	Masonry	Moisture Protection	Metals	Weighted Average
Oklahoma					
Oklahoma City	90.8	87.3	91.6	92.4	93.7
Tulsa	84.8	90.4	93.7	100.5	93.7
Oregon					
Eugene	112.6	111.0	94.0	108.2	108.6
Portland	105.2	113.5	92.9	108.3	108.5
Pennsylvania					
Allentown	93.6	89.3	94.9	105.4	96.6
Erie	90.8	98.7	96.6	98.3	97.0
Harrisburg	91.0	81.8	84.8	98.6	92.8
Philadelphia	97.5	91.5	103.0	102.8	98.2
Pittsburgh	102.1	104.1	98.7	99.7	99.5
Reading	91.0	89.7	88.7	97.9	94.2
Scranton	91.7	93.4	95.6	99.0	96.5
Rhode Island					
Providence	97.8	96.1	102.7	105.6	97.7
South Carolina					
Charleston	78.0	73.3	83.4	92.0	83.9
Columbia	80.1	72.0	87.8	96.5	83.5
South Dakota					
Sioux Falls	88.1	86.0	90.6	94.8	89.9
Tennessee					
Chattanooga	87.8	79.9	96.0	87.3	87.9
Knoxville	79.9	72.6	81.5	94.2	85.7
Memphis	90.4	91.8	100.5	92.5	92.7
Nashville	69.3	76.1	92.1	88.1	84.5
Texas					
Amarillo	91.7	85.4	88.7	92.6	90.7
Austin	82.4	89.6	91.4	90.3	90.2
Beaumont	93.6	107.0	96.1	97.7	98.3
Corpus Christi	81.9	79.9	87.3	92.3	87.2
Dallas	95.7	97.4	96.6	97.3	96.1
El Paso	76.0	75.8	88.7	95.3	85.8
Fort Worth	92.0	92.9	91.8	99.8	96.1
Houston	97.7	98.5	100.8	94.2	99.7
Lubbock	85.6	85.5	88.5	87.0	89.4
San Antonio	73.7	82.1	83.3	92.1	90.3

Table C.2 Geographic Adjustment Factors Used to Convert U.S. Average Cost Estimates to Their Local Equivalent Values for 156 Cities, by Type of Construction Activity (continued)

	Construction Activity				
State/City	Painting	Masonry	Moisture Protection	Metals	Weighted Average
Utah					
Salt Lake City	86.3	93.0	90.7	103.8	96.9
Vermont					
Burlington	85.9	74.9	83.6	97.4	89.3
Virginia					
Newport News	75.7	76.9	80.6	83.5	85.2
Norfolk	79.5	76.2	81.5	83.8	85.7
Richmond	79.6	79.3	83.4	91.1	88.4
Roanoke	75.9	70.3	80.7	90.4	85.0
Washington					
Seattle	106.4	114.9	108.4	106.5	106.5
Spokane	108.9	108.0	100.4	104.2	105.1
Tacoma	115.7	114.3	112.1	101.7	107.9
West Virginia					
Charleston	97.8	94.6	90.5	95.2	98.2
Huntington	99.5	95.5	90.9	100.2	98.4
Wisconsin					
Madison	94.3	90.4	88.3	95.8	93.8
Milwaukee	97.4	99.1	95.3	96.2	96.7
Wyoming					
Cheyenne	105.2	103.0	92.0	91.1	99.4

Source: Means, Building Construction Cost Data 1984, pp. 323-331.

APPENDIX D: OTHER ADJUSTMENTS

This appendix provides methods of adjusting the cost estimates given in appendix B to take into account the (1) base period, (2) labor type (union or non-union), (3) project type (new or repair and replacement), and (4) building project size. Each adjustment is discussed in turn and then an example is given for performing multiple adjustments to a cost estimate.

D.1. Base Period

All the cost estimates presented in appendix B have a base year of 1984, although the base period (i.e., month) within 1984 varies among the sources. Since more cost estimates are taken from the Means manuals, the following method is provided for converting the Berger and Dodge estimates to the same base period as Means (January 1984) for purposes of data consistency. To convert a cost estimate from Berger or Dodge to a corresponding January 1984 estimate, multiply it by the base-period conversion factor for that manual:

DODGE SYSTEMS	0.998
DODGE PRICING	0.993
BERGER	0.993

These factors were derived from a construction cost index focusing specifically on building construction: Dodge-McGraw Hill's Building Construction Cost Index, published in the Engineering News-Record and in two Department of Commerce publications, Construction Review and the Survey of Current Business. This monthly price index can be used to compute the percent change in building construction costs between any two time periods; it was used here to calculate the change from February to January 1984 (for the DODGE SYSTEMS manual) and the change from July to January 1984 (for the DODGE PRICING and BERGER manuals).

For example, appendix B (table B.15) reports a cost estimate from BERGER for copper roofing of \$7.00 per square foot. This figure is based on costs in July 1984. The equivalent estimate with a base period of January 1984 is \$6.95 per square foot (= 7.00 · 0.993).

D.2 Labor Type and Project Type

The labor type (union or non-union) employed for an MR&R activity needs to be taken into account because union labor wage rates are significantly higher than non-union rates. Table D.1 gives the cost of an MR&R activity using non-union labor as a percent of the cost of the same activity using union labor. These figures were calculated using union and non-union pay scales reported by trade in MEANS REP & REM and MEANS RES/LT COM, respectively. By applying these percentage amounts to the union labor based cost estimates of Appendix B (all but those from MEANS RES/LT COM), one will obtain equivalent non-union labor based cost estimates.

Repair and replacement construction generally involves higher overhead and profit rates than new construction. Table D.2 gives percentage amounts to be added to the new construction costs of Appendix B (all but those from MEANS REP & REM) to account for higher replacement construction overhead and profit.

Table D.1 MR&R Activity Cost Using Non-Union Labor, as a Percent of MR&R Activity Cost Using Union Labor

Building Component	Building Material	Percent
Walls	Paint	71.2
	Galvanized Steel	88.7
	Limestone	76.4
	Marble	71.6
	Masonry Mortar	71.3
Roofs	Galvanized Steel	88.7
	Copper	88.2
Gutters	Galvanized Steel	88.2
	Copper	88.2
Downspouts	Galvanized Steel	88.2
	Copper	88.2
Fences	Galvanized Steel	87.4

Sources: Table 2.2 of this report; Means, Building Construction Cost Data 1984, pp. viii-xxii; MEANS REP & REM, inside back cover; and MEANS RES/LT COM, inside back cover.

Table D.2 Percent to Add to MR&R Activity Cost with New Construction Overhead and Profit to Obtain Equivalent Cost with Replacement Construction Overhead and Profit

Building Component	Building Material	Percent to Add
Walls	Paint	5.5
	Galvanized Steel	1.5
	Limestone	4.2
	Marble	6.7
	Masonry Mortar	5.5
Roofs	Galvanized Steel	1.5
	Copper	1.1
Gutters	Galvanized Steel	1.1
	Copper	1.1
Downspouts	Galvanized Steel	1.1
	Copper	1.1
Fences	Galvanized Steel	2.3

Sources: Table 2.2 of this report; Means, Building Construction Cost Data 1984, pp. viii-xxii and 334; and MEANS REP & REM, inside back cover.

If a cost estimate is to be converted from both a union to a non-union labor base and from new construction overhead and profit to replacement construction overhead and profit, the percentage amounts in table D.3 must be applied. Table D.3 gives the cost of an MR&R activity using non-union labor with replacement construction overhead and profit as a percent of the cost of the same activity using union labor with new construction overhead and profit. DO NOT use tables D.1 and D.2 together to perform this conversion.

For replacement construction, special measures must sometimes be taken that add to the MR&R activity cost. MEANS REP & REM has developed a system for taking these special job requirements into account. Table D.4 gives percentage amounts, based on figures reported in MEANS REP & REM, to be added to MR&R activity cost estimates if the activities require that any of the special measures listed be taken. The figures in table D.4 apply only to replacement MR&R activity cost estimates; new construction costs must be adjusted for replacement construction overhead and profit BEFORE these replacement construction special job requirements are accounted for. Note that if more than one special measure is necessary, one should apply the percentage amount for one of the measures to the replacement MR&R activity cost, and then to the result apply the percentage amount for a second measure[1], and so forth until all special measures are accounted for. The special job requirements included in the table are defined in MEANS REP & REM as follows:[2]

1. Dust and noise protection of adjoining non-construction areas can alter usual construction methods.

2. Equipment usage curtailment resulting from physical limitations of the project may force workmen to use slow hand-operated equipment instead of power tools.

3. The confines of an enclosed building have a costly influence on movement and material handling.

4. On some repair or remodeling projects completed work must be secured or otherwise protected from possible damage during construction. In certain areas completed work must be guarded to prevent theft and vandalism.

5. Work may have to be done on other than normal shifts and may have to be done around an existing production facility in operation during the repair and remodeling project.

6. Requirements for shoring and bracing to hold up the building while structural changes are being made will affect costs.

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[1]Telephone conversation with Melville J. Mossman, MEANS REP & REM, 9/17/85.

[2]See pp. 6-7.

Table D.3 MR&R Activity Cost Using Non-Union Labor with Replacement Construction Overhead and Profit, as a Percent of MR&R Activity Cost Using Union Labor with New Construction Overhead and Profit

Building Component	Building Material	Percent
Walls	Paint	74.7
	Galvanized Steel	89.7
	Limestone	79.1
	Marble	75.0
	Masonry Mortar	74.7
Roofs	Galvanized Steel	89.7
	Copper	88.8
Gutters	Galvanized Steel	88.8
	Copper	88.8
Downspouts	Galvanized Steel	88.8
	Copper	88.8
Fences	Galvanized Steel	88.8

Sources: Table 2.2 of this report; Means, Building Construction Cost Data 1984, pp. viii-xii and 334; MEANS REP & REM, inside back cover; and MEANS RES/LT COM, inside back cover.

If a cost estimate is to be converted from both a union to a non-union labor base and from new construction overhead and profit to replacement construction overhead and profit, the percentage amounts in table D.3 must be applied. Table D.3 gives the cost of an MR&R activity using non-union labor with replacement construction overhead and profit as a percent of the cost of the same activity using union labor with new construction overhead and profit. DO NOT use tables D.1 and D.2 together to perform this conversion.

For replacement construction, special measures must sometimes be taken that add to the MR&R activity cost. MEANS REP & REM has developed a system for taking these special job requirements into account. Table D.4 gives percentage amounts, based on figures reported in MEANS REP & REM, to be added to MR&R activity cost estimates if the activities require that any of the special measures listed be taken. The figures in table D.4 apply only to replacement MR&R activity cost estimates; new construction costs must be adjusted for replacement construction overhead and profit BEFORE these replacement construction special job requirements are accounted for. Note that if more than one special measure is necessary, one should apply the percentage amount for one of the measures to the replacement MR&R activity cost, and then to the result apply the percentage amount for a second measure[1], and so forth until all special measures are accounted for. The special job requirements included in the table are defined in MEANS REP & REM as follows:[2]

1. Dust and noise protection of adjoining non-construction areas can alter usual construction methods.

2. Equipment usage curtailment resulting from physical limitations of the project may force workmen to use slow hand-operated equipment instead of power tools.

3. The confines of an enclosed building have a costly influence on movement and material handling.

4. On some repair or remodeling projects completed work must be secured or otherwise protected from possible damage during construction. In certain areas completed work must be guarded to prevent theft and vandalism.

5. Work may have to be done on other than normal shifts and may have to be done around an existing production facility in operation during the repair and remodeling project.

6. Requirements for shoring and bracing to hold up the building while structural changes are being made will affect costs.

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[1]Telephone conversation with Melville J. Mossman, MEANS REP & REM, 9/17/85.

[2]See pp. 6-7.

Table D.3 MR&R Activity Cost Using Non-Union Labor with Replacement Construction Overhead and Profit, as a Percent of MR&R Activity Cost Using Union Labor with New Construction Overhead and Profit

Building Component	Building Material	Percent
Walls	Paint	74.7
	Galvanized Steel	89.7
	Limestone	79.1
	Marble	75.0
	Masonry Mortar	74.7
Roofs	Galvanized Steel	89.7
	Copper	88.8
Gutters	Galvanized Steel	88.8
	Copper	88.8
Downspouts	Galvanized Steel	88.8
	Copper	88.8
Fences	Galvanized Steel	88.8

Sources: Table 2.2 of this report; Means, Building Construction Cost Data 1984, pp. viii-xii and 334; MEANS REP & REM, inside back cover; and MEANS RES/LT COM, inside back cover.

Table D.4 Percent to Add to Replacement MR&R Activity Cost to Account for Special Job Requirements, by Building Component and Material and by Job Requirement [Minimum % - Maximum %]

Building Component & Material	Special Job Requirement					
	Dust Protection	Equipment Usage Curtailment	Material Handling & Storage Limitation	Protection of Existing Work	Shift Work Requirements	Temporary Shoring & Bracing
WALLS						
Paint	1.8-9.5	1.0-8.5	1.0-6.8	2.0-6.6	3.9-23.4	4.3-10.5
Galvanized Steel	1.3-6.1	1.0-5.1	1.0-6.3	2.0-5.6	1.5- 9.2	2.9- 7.1
Limestone	1.5-8.1	0.9-7.2	0.9-5.9	1.8-5.7	3.3-19.6	3.7- 9.0
Marble	1.8-9.4	1.0-8.4	1.0-6.8	2.0-6.5	3.9-23.2	4.3-10.4
Masonry Mortar	1.8-9.4	1.0-8.4	1.0-6.8	2.0-6.5	3.9-23.2	4.3-10.4
ROOFS						
Galvanized Steel	1.3-6.1	1.0-5.1	1.0-6.3	2.0-5.6	1.5- 9.2	2.9- 7.1
Copper	1.4-6.6	1.0-5.2	1.0-6.3	2.0-5.6	1.6- 9.4	2.9- 7.2
GUTTERS						
Galvanized Steel	1.4-6.6	1.0-5.2	1.0-6.3	2.0-5.6	1.6- 9.4	2.9- 7.2
Copper	1.4-6.6	1.0-5.2	1.0-6.3	2.0-5.6	1.6- 9.4	2.9- 7.2
DOWNSPOUTS						
Galvanized Steel	1.4-6.6	1.0-5.2	1.0-6.3	2.0-5.6	1.6- 9.4	2.9- 7.2
Copper	1.4-6.6	1.0-5.2	1.0-6.3	2.0-5.6	1.6- 9.4	2.9- 7.2
FENCES						
Galvanized Steel	1.3-6.4	1.0-5.4	1.0-6.3	2.0-5.7	1.7-10.4	3.0- 7.4

Sources: Table 2.2 of this report and MEANS REP & REM, pp. xv, xvi, and 6.

D.3 Economies of Scale

The following equation can be used to adjust cost estimates for building project sizes that differ from the project size assumed by the published data source in which the cost estimate was found:

$$y = 1.03 - .03\ x,$$

where y = the adjustment factor, and
x = the ratio of desired project size to data source project size.[1]

For example, suppose one wants to apply a cost estimate for replacing galvanized steel siding from a data source reporting costs from $1,000,000 building projects to a building project costing $500,000. The galvanized steel siding cost estimate reported in the data source is $1.50 per square foot. The ratio of desired to data source project sizes is 0.5 (= $500,000/$1,000,000). The adjustment factor is 1.015 (= 1.03 - .03(.5)). The resulting cost of replacing galvanized steel siding adjusted for a $500,000 building project is $1.52 per square foot (= 1.50 · 1.015).

D.4 Performing More than One Adjustment

If more than one cost data adjustment is necessary, they may be performed in any sequence, including the geographic adjustments given in appendix C. The following example illustrates how multiple adjustments can be applied to a single MR&R activity cost estimate from appendix B.

Suppose a 1.5 inch thick marble wall is to be replaced. Assume that non-union labor is to be used, surrounding non-construction areas must be kept free of dust, and the work must be performed on early morning shifts. One of the cost estimates from MEANS REP & REM for this MR&R activity is $27.42 per square foot. (See appendix B, table B.11, item 14.)

Since the cost estimate is from MEANS REP & REM, an adjustment to non-union labor must be made. Special job requirements apply, so replacement rather than new construction cost estimates must be used. MEANS REP & REM gives such replacement cost estimates, so that the adjustment given in table D.2 for replacement versus new construction overhead and profit need not be made in this case. Thus, table D.1 can be used for the labor type conversion. There one finds that replacing marble walls with non-union labor will cost 71.6 percent of the $27.42 cost for replacing marble walls with union labor. So the estimate now becomes $19.63 per square foot (= 27.42 · 0.716).

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[1]This equation was derived from a figure found in Means, Building Construction Cost Data 1984, p. 402. In a telephone conversation 7/8/85, Melville J. Mossman of Means indicated that the equation could be used to extrapolate beyond the range of values given in the figure. He also confirmed that the equation could be applied to MR&R activities in addition to entire building projects.

Now the two special job requirements can be taken into account. The amount to be applied to a replacement MR&R activity cost estimate for marble walls to account for both dust protection and shift work requirements can be derived from table D.4 as follows: the minimum is 1.058 (= 1.018 · 1.039); and the maximum is 1.348 (= 1.094 · 1.232). Consequently, the cost estimate for replacing marble walls adjusted for both labor type and special job requirements is, at a minimum, \$20.77 per square foot (= 19.63 · 1.058), and at a maximum, \$26.46 per square foot (= 19.63 · 1.348).

NBS-114A (REV. 2-80)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET (See instructions)	1. PUBLICATION OR REPORT NO.	2. Performing Organ. Report No.	3. Publication Date
	NBSIR-85/3253		October 1985

4. TITLE AND SUBTITLE

A Life-Cycle Cost Data Base for Assessing Acid Deposition Damage to Common Building Materials

5. AUTHOR(S)

Weber, Stephen F.; Lippiatt, Barbara C.; Wiener, Matthew

6. PERFORMING ORGANIZATION *(If joint or other than NBS, see instructions)*

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

7. Contract/Grant No.

8. Type of Report & Period Covered

Final

9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS *(Street, City, State, ZIP)*

U.S. Environmental Protection Agency
Washington, DC 20460
As part of the National Acid Precipitation Assessment Program
Materials Effects Task Group (Group G)

10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)*

This report presents and documents cost data for the most economically significant building materials suspected of being damaged by acid deposition. The data are presented in the form of cost estimates for relevant maintenance, repair, and replacement (MR&R) activities, and are organized both by building component and by building material. The building components covered in this report include walls, roofs, fences, rain gutters, and downspouts. The materials covered include paint, limestone, marble, galvanized steel, copper, and masonry mortar. The documentation describes the data sources and presents detailed technical specifications for each of the 360 cost estimates contained in the data base. Summary statistics are presented for groups of MR&R activities, and the techniques of analysis of variance and regression analysis are used to address the problem of variation in the cost estimates within the same activity group. The report also explains and illustrates how the cost data can be used to estimate the economic cost of acid deposition damage to common building components and materials.

12. KEY WORDS *(Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)*

acid rain; buildings; cost data; damage; data base; economics; environment; life-cycle cost; maintenance; materials; repair; replacement

13. AVAILABILITY

[x] Unlimited
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[xx] Order From National Technical Information Service (NTIS), Springfield, VA. 22161

14. NO. OF PRINTED PAGES

84

15. Price

$11.95